

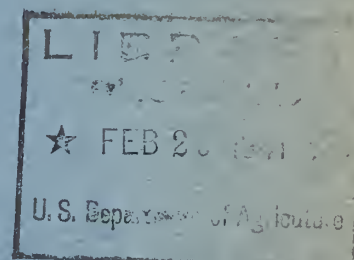
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UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service
and
Bureau of Agricultural Chemistry and Engineering



THE COMPRESSION OF COTTON, AND RELATED PROBLEMS

By

John W. Wright, Senior Agricultural Economist,
Agricultural Marketing Service

and

Charles A. Bennett, Senior Mechanical Engineer,
Bureau of Agricultural Chemistry and Engineering

Washington, D. C.
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THE PLACE OF THE COMPRESS INDUSTRY IN THE MARKETING OF AMERICAN COTTON

The cotton compress industry occupies an important position in the present system of marketing and handling American cotton. Except in those areas in the Southeastern States where most of the cotton goes from gins direct to local mills and in the limited number of instances when cotton is packed in round bales of high density at gins, the American cotton crop passes through compress plants while en route from gins to cotton mills. The cotton merchant trade depends on the compress industry for numerous services in connection with the physical handling of the cotton that are incident to the processes of concentration and merchandising.

Necessity for Compression

The cotton crop, practically all of which enters commercial channels, is one of the most bulky of American crops. The present system of packaging cotton at the gin in so-called "square" or "flat" bales of low density, necessitates the compression of these gin bales to greater density in order to effect economies in the

1/ The study upon which this report is based was made possible by a grant from Bankhead-Jones special research funds administered under the direction of Dr. James T. Jardine, Director of Research, U. S. Department of Agriculture. This study is a part of a broader study dealing with the packaging of American raw cotton.

2/ The following have participated in the study: F. L. Gerdes, Cotton Technologist; L. J. Watson, Associate Marketing Specialist; C. S. Shaw, Assistant Cotton Technologist; G. E. Gaus, Associate Marketing Specialist, all of the Agricultural Marketing Service; V. L. Stedronsky, Associate Mechanical Engineer, and W. H. Kliever, Associate Engineer-Physicist, Bureau of Agricultural Chemistry and Engineering. Several members of the field staff of the Agricultural Marketing Service assisted in conducting a preliminary survey of the cotton compress industry.

The study was made possible by the cooperation of the cotton compress and warehouse industry.

transportation and storage of the cotton. The bales as turned out at the gin usually average a little more than 500 pounds in weight and represent a volume of about 40 cubic feet, the average density being about 13 pounds per cubic foot. The compression process permits of reducing the cubical contents of the bale to about one-half or less of its original volume. This makes possible substantial economies in transportation and storage.

Incidental Services

Although the compression of cotton is the basic service performed by the compress industry, many other services incident to the handling and marketing of cotton are performed. Among these are weighing, sampling, marking, insurance, reconditioning, storage, and many others. For the season 1932-33, only about 30 percent of the total revenues of compress companies was derived from compression service whereas 50 percent was derived from storage and 20 percent from other services. 3/ Subsequently, the Federal cotton loan program has, perhaps, increased the proportion of receipts represented by storage service.

The characteristics of the commodity and the manner in which it enters marketing channels, on the one hand, and the requirements of cotton manufacturers, on the other, make the concentration of cotton essential to effective merchandising. The cotton crop of the United States is produced on more than two million farms. The production per individual farm varies from less than a bale to several thousand bales, with an average for the entire Cotton Belt of about 5 or 6 bales per farm unit. Hundreds of varieties and strains of cotton are grown in the United States. These vary with respect to quality factors that are taken into account in utilization. Even on a single farm where only one variety is grown there are significant variations in the quality of the cotton produced, as a result, primarily, of variations in soil and of weather conditions during the harvesting season.

Cotton manufacturers require for specific uses, cotton conforming to rather exacting specifications with respect to the various elements of quality. They usually prefer to obtain their supplies of raw cotton in lots that are uniform in quality and that consist of 50 or 100 bales or multiples thereof in order to facilitate trading, shipment, and hedging. Under these circumstances, one of the principal functions of cotton merchandising is to assemble the lots of cotton of varying qualities and quantities as placed on the market by growers and sort them into commercial lots of uniform qualities for delivery as desired by cotton mills.

3/ The Cotton Compress and Warehouse Industry. A preliminary report prepared by the Division of Economic Research and Planning, National Recovery Administration, 1934. p. 9. (Unpublished)

The physical handling of the bales in connection with this process of concentration for distribution to domestic mills or for export usually is performed by the compress industry incident to the process of compression. It is the function of the cotton compress and warehouse industry to provide the cotton trade with the facilities and services required incident to the merchandising of the cotton. Cotton merchants seldom see the actual bales which they merchandise. They depend very largely upon the cotton compress and warehouse industry to perform all essential services associated with the physical handling of the bales.

THE DEVELOPMENT OF THE COMPRESS INDUSTRY

Although complete information relative to the development of the cotton compress industry is not available, indications are that the initial development of compress facilities took place at the principal cotton ports where economy in ship cargo space was a necessity. Later came the development of compress facilities at interior points as a means of economy in connection with inland transportation and storage.

The first heavy machinery for compressing cotton was installed at the port of New Orleans in 1832 where, for more than a decade, the only compressing facilities were located. 4/ On the Atlantic seaboard, compressing facilities were first provided in 1844 when a compress was installed at Savannah, Ga.

During the early period of the cotton industry in the United States, the merchandising of raw cotton was very largely centered in a few of the principal cotton ports where facilities for assembling, storing, financing, and compressing were available. In 1859, the port of New Orleans alone is reported to have been handling approximately 50 percent of the United States cotton crop. 5/

With the expansion of cotton production into areas more distant from ports and the building of railroads into cotton-producing areas throughout the interior, the problem of economical inland transportation of the bulky bales of cotton turned out at gins led to the development of compress facilities in the interior. To a considerable extent, these facilities were owned and operated by the railroads. Later the railroads disposed of their interests in compress facilities.

During the early period of the development of the compress industry, ocean freight rates for cotton were based on low-density gin bales. The steamship companies paid for the compression of the

4/ Allred, C. A., and Raskopf, B. D., Cotton Compressing in Tennessee and the United States. Agricultural Experiment Station, University of Tennessee, Rural Research Series, Monograph No. 71, 1938, p. 2.

5/ Interstate Commerce Commission Reports, Volume 2, p. 290.

bales to enable them to utilize more effectively their cargo space. This practice continued for sometime even after compress equipment was installed at interior points. That is to say, the interior compresses were paid by the steamship companies for the compression of cotton ultimately transported by these companies. Subsequently, the basis for ocean freight rates was changed to compressed bales and the railroads assumed the cost of compression whether performed by their own compresses or those owned by other agencies. This was done to enable the rail carriers to economize in the use of their transportation equipment. The payment of compression charges by the railroads has been continued to the present time under the compress-in-transit rail rate system. Subsequent to the inauguration of carload rates in 1932, however, cotton shippers have paid for compression service when used to enable them to take advantage of such rates.

Full details are not available relative to the types of equipment used during the early development of the compress industry. It appears, however, that most of the equipment was designed to provide a density comparable to that of "standard" compression of the present time, or about 22 pounds per cubic foot. Apparently there were many attempts to develop methods and equipment designed to attain higher densities, particularly for purposes of ocean transportation. According to information supplied by manufacturers of compress equipment and by some of the principal operators of such equipment, these efforts began shortly after the Civil War and continued until about 1900, when a high-density steam press similar to the type now generally used in the United States and providing a density of approximately 32 pounds per cubic foot, was installed at Savannah, Ga. The second press of this type was installed at Waco, Tex., in 1901. This was followed by installations at Canton and Corinth, Miss., in 1906, and at Memphis, Tenn., in 1907.

For some time after the development of high-density equipment of present types, most of the compress equipment located at interior points was designed for standard-density compression only. The facilities located at ports were equipped for high-density compression. More recently competitive conditions have led to the installation of high-density equipment at many interior points. The inauguration of carload rates in 1932, which have in some instances encouraged loadings somewhat heavier than usually can be attained with standard-density bales, tended to accentuate this development. Since, in order to obtain the lowest available ocean rates, cotton exported must be compressed to high density, considerable cotton is now compressed to high density in the interior in order to obviate the need for recompression at ports.

GEOGRAPHICAL DISTRIBUTION OF COMPRESS INDUSTRY

Cotton compress plants usually have been located at strategic points with respect to areas of cotton production and lines of movement of the cotton (fig. 1). The heaviest concentration of such establishments is in the Mississippi Valley, where cotton production is relatively large, and at the various ports where the cotton moves for concentration and distribution to domestic mill centers and to export markets.

There is a relative sparsity of compresses in the Southeastern States where cotton production is comparatively heavy. This is explained by the fact that the extra expense of compressing cotton bales is justified only when the cotton is to be transported considerable distances. As the major portion of the cotton produced in the Southeastern States is consumed by local mills, only a minor part of the cotton is compressed.

In the central and southwestern areas of cotton production, practically all the cotton crop is of necessity transported relatively long distances to domestic mill points, which are concentrated in the Southeast and in New England, or to export markets. Under these circumstances, practically all of the cotton is compressed at or near the place of growth or at the point where it is concentrated for merchandising. This situation explains the fact that these areas are well supplied with compress facilities.

These regional differences with respect to practices associated with the handling and compression of cotton are apparent from the fact that although the Southeastern States produce more than 25 percent of the United States cotton crop, only about 12 percent of all compress plants in the United States are located in these States and less than 5 percent of the total cotton compressed is compressed there (table 1). The average volume per compress in the Southeast is only about one-third of that for compresses in the central and southwestern parts of the Cotton Belt.

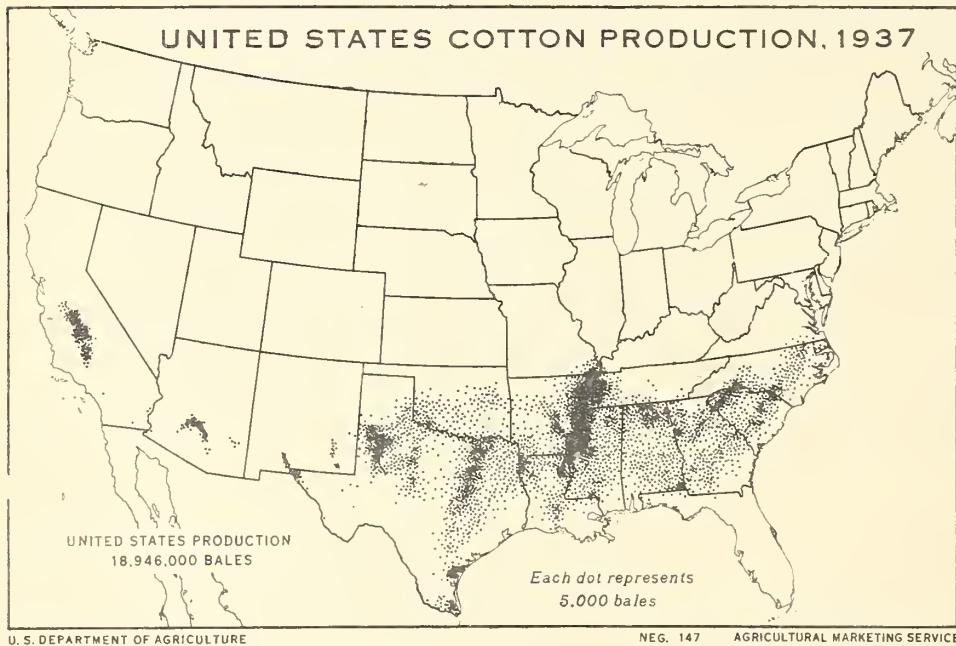
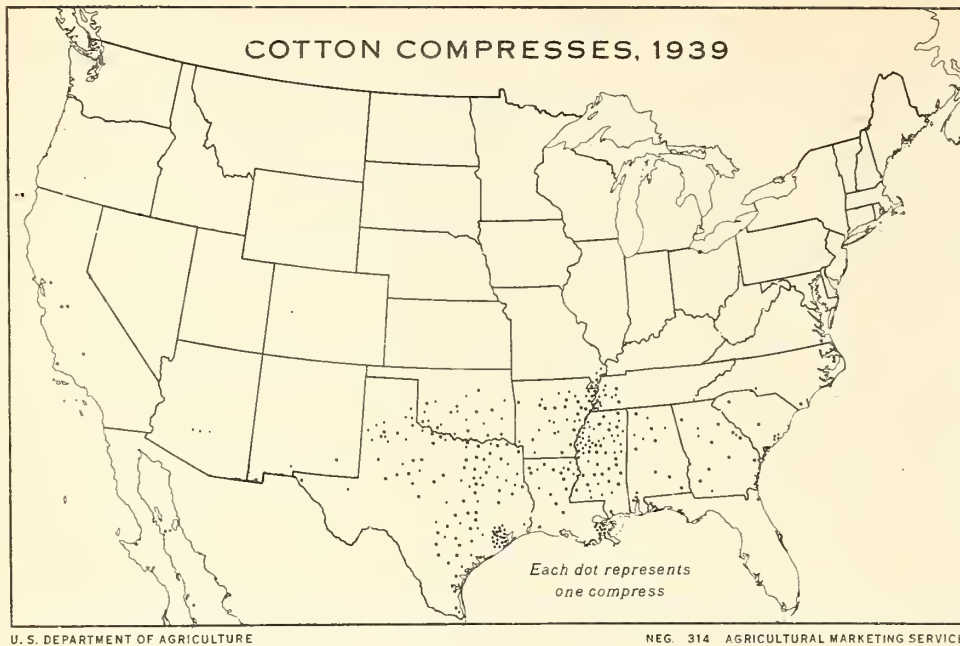


FIGURE 1. - LOCATION OF COTTON COMPRESSES WITH RESPECT TO AREAS OF COTTON PRODUCTION.

The top section shows the geographic distribution of cotton compresses in the United States as of 1939. The lower section shows the areas of cotton production in the United States as of 1937. Compresses are located at the principal cotton ports and at points throughout the interior of the Cotton Belt that are strategically located with respect to producing areas and the lines of movement of the cotton in channels of distribution.

Table 1. - Cotton compresses, cotton produced, and cotton compressed in specified States and regions, season 1937-38

State and region	Compresses			Cotton produced			Cotton compressed				
	Percent:			Percent:			Percent:				
	Number:	of U. S.	Bales	of U. S.	Bales	of U. S.					
	:total	:	:	:total	:	:total					
	:	:	:	:	:	:	:	:	:		
Alabama	15	:	4.6	:	1,566,602	:	8.6	:	224,635	:	1.9
Florida	2	:	.6	:	35,363	:	.2	:	34,200	:	.3
Georgia	14	:	4.3	:	1,473,984	:	8.1	:	143,507	:	1.2
New Jersey	1	:	.3	:		:		:		:	
North Carolina ..	2	:	.6	:	780,594	:	4.3	:	10,028	:	.1
South Carolina ..	5	:	1.6	:	996,175	:	5.4	:	109,358	:	.9
Virginia	1	:	.3	:	40,215	:	.2	:	9,454	:	.1
Total	:	:	:	:	:	:	:	:	:	:	:
Southeast ..	40	:	12.3	:	4,892,933	:	26.8	:	531,182	:	4.5
	:	:	:	:	:	:	:	:	:	:	:
Arkansas	33	:	10.2	:	1,808,840	:	9.9	:	1,115,845	:	9.5
Louisiana	27	:	8.3	:	1,050,629	:	5.8	:	1,554,370	:	13.2
Mississippi	58	:	17.9	:	2,561,778	:	14.0	:	1,891,218	:	16.1
Missouri	6	:	1.9	:	390,219	:	2.1	:	214,713	:	1.8
Tennessee	14	:	4.3	:	633,335	:	3.5	:	688,405	:	5.8
Other	:	:	:	:	18,498	:	.1	:		:	
Total	:	:	:	:	:	:	:	:	:	:	:
Mississippi	:	:	:	:	:	:	:	:	:	:	:
Valley ..	138	:	42.6	:	6,463,299	:	35.4	:	5,464,551	:	46.4
	:	:	:	:	:	:	:	:	:	:	:
Arizona	2	:	.6	:	310,199	:	1.7	:	168,385	:	1.4
California	5	:	1.6	:	723,035	:	4.0	:	741,731	:	6.3
New Mexico	2	:	.6	:	153,812	:	.8	:	139,318	:	1.2
Oklahoma	23	:	7.1	:	756,419	:	4.2	:	504,326	:	4.3
Texas	114	:	35.2	:	4,952,378	:	27.1	:	4,218,114	:	35.9
Total	:	:	:	:	:	:	:	:	:	:	:
Southwest ..	146	:	45.1	:	6,895,843	:	37.8	:	5,771,874	:	49.1
	:	:	:	:	:	:	:	:	:	:	:
United States ..	324	:	100.0	:	18,252,075	:	100.0	:	11,767,607	:	100.0

Data relative to production based on reports of U. S. Bureau of the Census; data relative to compression based on survey of cotton compresses conducted by the Agricultural Marketing Service.

ORGANIZATION OF THE INDUSTRY

A cotton compress establishment represents a relatively large investment for press equipment and other facilities needed for handling cotton in connection with compression and concentration. Because of the capital required and the various risks incident to the business, most compress facilities are operated under the corporate form of business organization.

For the most part, the compress industry is operated as large-scale integrated enterprises. Approximately 75 percent of the compresses of the United States, handling about 78 percent of all cotton compressed, are operated as multiple units or chain organizations (table 2). Only about 25 percent of the compresses, handling about 22 percent of the cotton, are operated as local independent enterprises. In the Southeast, about 52 percent of the compresses are independent local enterprises as compared with 23 percent and 20 percent, respectively, in the Mississippi Valley and the Southwest.

The cotton compress industry is to a considerable extent integrated vertically as well as horizontally. That is to say, not only is a large segment of the cotton compress industry operated by chain organizations, but, in many instances, owners of compress facilities are engaged in related enterprises such as the ginning and merchandising of cotton. There is a very close affiliation of the compress industry with cotton merchandising. A substantial proportion of the compresses are operated by companies which are subsidiaries of cotton merchandising firms. In many other cases, cotton merchants are owners of stock in compress companies.

Compress facilities at several of the cotton ports are State-owned or municipally owned. In some instances, these facilities are operated as private enterprises under lease.

COMPRESS EQUIPMENT

Number of Compress Establishments and Presses

In 1939 there were 324 compress establishments in the United States, including 358 press installations (table 3). Twenty-eight establishments had 2 presses each and 3 had 3 presses each. A total of 336 presses were in active operation during the season 1937-38 (table 4).

Table 2. - Cotton compresses operated as single and multiple units and cotton compressed, by States and regions, season 1937-38

State and region	Operated as							
	Single units				Multiple units			
	Presses		Cotton		Presses		Cotton	
	Number	Pct.	Bales	Pct.	Number	Pct.	Bales	Pct.
Alabama	9	60.0	104,210	46.4	6	40.0	120,425	53.6
Florida	1	50.0	2,000	5.9	1	50.0	32,200	94.1
Georgia	4	25.0	26,661	18.7	12	75.0	116,040	81.3
New Jersey	1	100.0						
North Carolina ..	1	50.0	1,700	17.0	1	50.0	8,328	83.0
South Carolina ..	6	85.7	106,300	97.2	1	14.3	3,058	2.8
Virginia	1	100.0	9,454	100.0				
Total								
Southeast	23	52.3	250,325	47.2	21	47.7	280,051	52.8
Arkansas	4	11.1	119,894	10.7	32	88.9	995,926	89.3
Louisiana	8	25.8	224,738	14.5	23	74.2	1,323,582	85.5
Mississippi	17	28.8	483,347	25.6	42	71.2	1,407,871	74.4
Missouri	3	50.0	99,797	46.5	3	50.0	114,916	53.5
Tennessee	2	13.3	142,100	20.7	13	86.7	545,443	79.3
Total								
Mississippi								
Valley	34	23.1	1,069,876	19.6	113	76.9	4,387,738	80.4
Arizona					2	100.0	168,385	100.0
California	2	33.3	194,000	26.2	4	66.7	547,731	73.8
New Mexico	2	100.0	139,318	100.0				
Oklahoma					27	100.0	504,178	100.0
Texas	29	22.3	917,836	21.8	101	77.7	3,296,043	78.2
Total								
Southwest	33	19.8	1,251,154	21.7	134	80.2	4,516,337	78.3
United States	90	25.1	2,571,355	21.9	268	74.9	9,184,126	78.1

Data based on a survey of cotton compresses conducted by the Agricultural Marketing Service.

Table 3. - Cotton compress establishments and press installations, by States, season 1938-39

State	Compress establish- ments	Compress establish- ments with --			Total presses
		1	2	3	
		press	presses	presses	
	Number	Number	Number	Number	Number
Alabama	15	15			15
Arizona	2	2			2
Arkansas	33	30	3		36
California	5	4	1		6
Florida	2	2			2
Georgia	14	12	2		16
Louisiana	27	25		2	31
Mississippi	58	57	1		59
Missouri	6	6			6
New Jersey	1	1			1
New Mexico	2	2			2
North Carolina	2	2			2
Oklahoma	23	19	4		27
South Carolina	5	3	2		7
Tennessee	14	13	1		15
Texas	114	99	14	1	130
Virginia	1	1			1
United States	324	293	28	3	358

Data based on a survey of cotton compresses conducted by the Agricultural Marketing Service.

Types of Equipment

Two types of compression for so-called "square" cotton bales customarily are used in the United States, namely, "standard density" and "high density." In compressing bales to standard density, the gin bales are placed in the press in the position as originally formed at the gin and pressure applied vertically to reduce their thickness. If higher densities are required, the bales are first pressed from the two sides to reduce their width, then vertically to reduce their thickness. Essentially the same types of equipment are used for both types of compression, the difference being that for high-density compression the press equipment includes a pair of so-called side doors for reducing the width of the bales and for holding them in position while vertical pressure is applied. High-density

presses are able to perform standard-density compression by omitting the side door operation. With few exceptions, a special lower-platen attachment is used on such presses for standard-density compression. Of the 358 presses in the United States, 287 are equipped for both high-density and standard-density compression whereas 71 are equipped for standard-density compression only (table 4).

From the standpoint of the principle employed in applying pressure for compression, there are three distinct types of compress equipment now in use in the United States. These are: (1) steam cylinder, (2) hydraulic, and (3) geared mechanical.

The steam-cylinder type of press is used much more extensively than either of the other two types (fig. 2). Of the 358 presses in the United States, 333 employ the steam-cylinder principle of compression, 9 are hydraulic, and 16 are geared-mechanical presses.

The relative importance of these three types of presses is indicated by the fact that about 95 percent of the cotton compressed during the season 1937-38 was compressed by steam-cylinder presses as compared with 1 percent and 4 percent for the hydraulic and the geared-mechanical presses, respectively.

There are several makes of each of the three types of presses. Differences between the various makes of steam presses, from the standpoint of the mechanical principles involved and method of operation, are not great. The same is true of the various makes of hydraulic presses. There are, however, significant differences in the systems of leverage employed by the various makes of presses grouped under the designation "geared mechanical." These include cable-actuated cam levers, worm and sectors, and geared fly-wheel discs. The source of power employed by the geared-mechanical types of presses varies also and includes electric motors, internal combustion engines, and horizontal steam engines.

Pressures Employed

Cotton-compress equipment is characterized by its massive size and the enormous pressures exerted on the bales of cotton. Some of the steam presses weigh as much as 350 tons. Observed pressures applied for standard-density compression by the customary types of steam-cylinder presses, range from 744 to 1,637 pounds per square inch of bale surface in contact with the press platen. This represents a total pressure on the cotton bale of from about 1,250,000 to 2,750,000 pounds or 625 to 1,375 tons.

Table 4. - Cotton compresses and volume of cotton compressed, by type of compression and type of equipment, season 1937-38

Type of compress equipment	Presses			Cotton compressed to		
	: Active :	: Idle :	: Total :	: Standard : density :	: High : density :	: Total :
	: Number :	: Number :	: Pot. : Number :	: Bales : Pot. : density :	: Bales : Pot. : density :	: Bales : Pot. : density :
Standard density: <u>1/</u>						
Steam oylinder	49 :	6 :	55 :	15.4 : 983,618 :	8.0 :	8.0 :
Hydraulic	5 :	2 :	7 :	2.0 : 106,085 :	.9 :	.9 :
Gearred mechanical	7 :	2 :	9 :	2.5 : 57,727 :	.5 :	.5 :
Total standard density ..	61 :	10 :	71 :	19.9 : 1,147,430 :	9.4 :	9.4 :
High density: <u>2/</u>						
Steam oylinder	266 :	12 :	278 :	77.6 : 3,134,311 :	87.2 :	87.2 :
Hydraulic	2 :	0 :	2 :	.6 : 39,234 :	.4 :	.4 :
Gearred mechanical	7 :	0 :	7 :	1.9 : 128,952 :	3.0 :	3.0 :
Total high density	275 :	12 :	287 :	80.1 : 3,302,497 :	90.6 :	90.6 :
All types	336 :	22 :	358 :	100.0 : 4,449,927 :	100.0 :	100.0 :

Data based on a survey of cotton compresses conducted by the Agricultural Marketing Service.

1/ Includes compresses equipped for standard-density compression only.

2/ Includes compresses equipped for both types of compression.

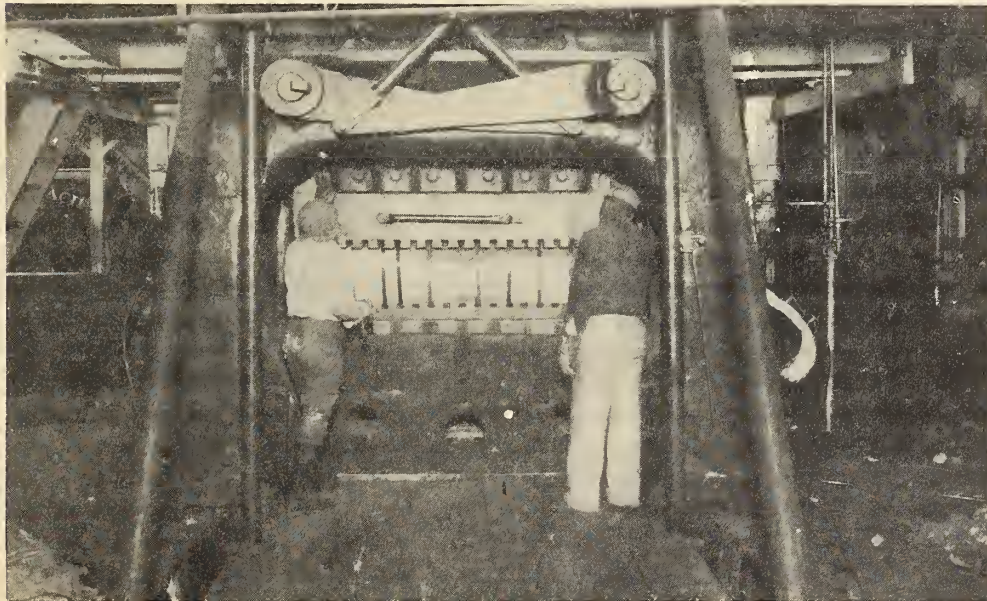
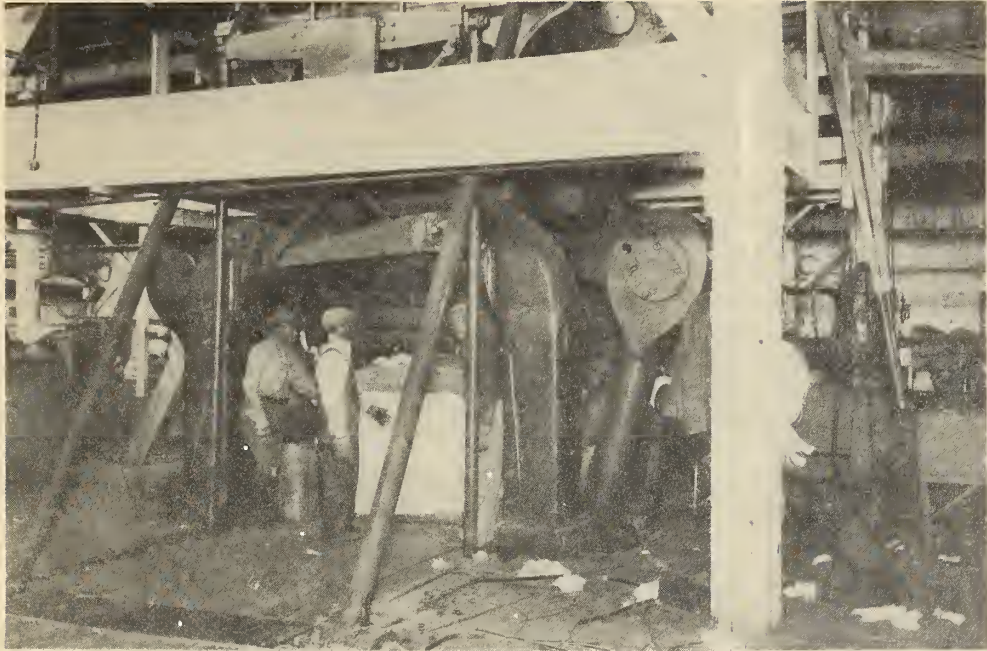


FIGURE 2. - STEAM-CYLINDER COMPRESS.

Top section shows a gin bale in place immediately before compression.
Lower section shows bale after compression with ties in
place and ready to be released from press.

For high-density compression, pressures vary from 980 to 2,155 pounds per square inch of bale surface in contact with the press platen. The surface area of the bale in contact with the press platen is smaller than for standard-density compression. The range in total pressures is the same.

Wide variations in pressures exerted on individual bales are accounted for by differences in the actual density attained and by differences in pressure required to attain a given density for bales varying in weight and in the moisture content of the cotton.

Boiler pressures carried at steam-cylinder compresses vary from about 90 to 160 pounds. The working steam pressure in the cylinder during compression varies from about 50 to 120 pounds, with an average of about 90 pounds. Although the diameters of the steam cylinders range from 72 inches to 100 inches, 250 of the 333 steam presses are equipped with cylinders 80 inches in diameter.

Time Rate of Compression

The volume of cotton compressed per hour varies materially as between compresses. The average rate is about 95 bales per hour for standard-density compression and 85 bales per hour for high-density compression (table 5). The extra operation involved in high-density compression reduces the number of bales that can be handled per unit of time.

Table 5. - Average rate of compression of cotton per hour, by type of compression and by type of equipment, season 1937-38

Type of compression and equipment	Average number of bales compressed per hour
	<u>Bales</u>
Standard density:	
Steam presses	96
Hydraulic presses	66
Geared-mechanical presses	73
All standard-density compression ..	94
High density:	
Steam presses	85
Hydraulic presses	50
Geared-mechanical presses	67
All high-density compression	85

Data based on a survey of cotton compresses conducted by the Agricultural Marketing Service.

The rate of compression varies also with the type of equipment used. For standard-density compression the averages for bales compressed per hour are 96, 66, and 73 for the steam-cylinder, hydraulic, and geared-mechanical types of presses, respectively. In the case of high-density compression, the average number of bales handled per hour is 85 for steam presses, 50 for hydraulic, and 67 for geared-mechanical.

The volume of cotton compressed per unit of time depends not only upon the type of compression and the type of equipment used but also upon the size, experience, and skill of the compress crew, the condition of the equipment, and the weight and condition of the bales to be compressed. Extra heavy bales require considerably more time for the compressing process. Likewise, very dry cotton is more difficult to compress than cotton of normal moisture content.

VOLUME OF COTTON HANDLED

Per Unit of Equipment

The volume of cotton handled per press varies from less than 5,000 bales to about 200,000 bales annually (table 6). More than two-thirds of the compresses handle a volume between 15,000 and 100,000 bales per year. About one-fourth of the compresses have an annual volume of less than 15,000 bales per year. Only about 5 percent of them have a volume in excess of 100,000 bales.

As a general rule, the compresses located at ports handle a larger volume of cotton than compresses located at interior points. The average volume per press at the ports was about 45,000 bales during the season 1937-38 as compared with an average of about 32,000 bales at interior locations. Less than 4 percent of the interior compresses had a volume in excess of 100,000 bales per press as compared with more than 9 percent for the port compresses.

The average volume per press in the Southeast was about 12,000 bales as compared with averages of 39,000 bales and 37,000 bales per press for the Mississippi Valley and the Southwest, respectively. None of the compresses in the Southeast handled a volume in excess of 50,000 bales during the season 1937-38.

By Type of Compression

For the Cotton Belt as a whole, slightly more than a third of the cotton compressed is compressed to standard density and almost two-thirds is compressed to high density (table 7). The proportions for the two types of compression vary, however, from year to year and for different sections of the Cotton Belt. In the Southeast, where

Table 6. - Volume of cotton compressed per active press, by State and regions, season 1937-38

State and region	Bales compressed per press										Average Total : per : press
	5,000 bales : and less :	5,001 to : 10,000 bales :	10,001 to : 15,000 bales :	15,001 to : 25,000 bales :	25,001 to : 50,000 bales :	50,001 to : 100,000 bales :	100,001 to : 150,000 bales :	150,001 to : 200,000 bales :	200,001 to : 250,000 bales :	250,001 to : 300,000 bales :	
	Pct. : Presses :	Pct. : Presses :	Pct. : Presses :	Pct. : Presses :	Pct. : Presses :	Pct. : Presses :	Pct. : Presses :	Pct. : Presses :	Pct. : Presses :	Pct. : Presses :	
Southeast:											
Alabama	4	26.7 :	5	20.0 :	2	13.3 :	4	26.7 :			15 : 14,975
Florida	1	50.0 :					1	50.0 :			2 : 17,100
Georgia	5	33.3 :	6	40.0 :	1	6.7 :	1	6.7 :			15 : 9,567
North Carolina	1	50.0 :	1	50.0 :							2 : 5,014
South Carolina	3	42.8 :			2	28.6 :	2	28.6 :			7 : 15,622
Virginia	1	100.0 :									1 : 9,454
Total Southeast	14	33.3 :	11	26.2 :	3	17.1 :	6	14.3 :	8	19.1 :	42 : 12,647
Mississippi Valley:											
Arkansas											
Louisiana	2	6.5 :	7	20.0 :	5	14.3 :	4	11.4 :	12	34.3 :	35 : 32,881
Mississippi	5	9.4 :	3	5.7 :	2	3.8 :	13	24.5 :	10	32.1 :	31 : 50,141
Missouri			1	16.7 :			4	66.6 :	8	35.8 :	53 : 35,683
Tennessee			2	13.3 :			4	26.7 :	4	26.7 :	6 : 35,786
Total Mississippi Valley ..	7	5.0 :	14	10.0 :	11	7.9 :	28	20.0 :	49	35.0 :	140 : 39,033
Southwest:											
Arizona											
California									1	50.0 :	2 : 84,193
New Mexico									3	50.0 :	6 : 123,622
Oklahoma	4	15.4 :	2	7.7 :	3	11.5 :	10	38.5 :	6	23.1 :	2 : 69,659
Texas	6	5.1 :	9	7.6 :	8	6.8 :	28	23.7 :	40	33.9 :	26 : 19,397
Total Southwest	10	6.5 :	11	7.1 :	11	7.1 :	38	24.7 :	47	30.6 :	118 : 35,747
United States	31	9.2 :	36	10.7 :	25	7.4 :	72	21.4 :	104	31.0 :	336 : 35,023
Compresses in interior	24	8.8 :	33	12.2 :	22	8.1 :	62	22.9 :	80	29.5 :	271 : 32,616
Compresses at ports	7	10.8 :	3	4.6 :	3	4.6 :	10	15.4 :	24	36.9 :	65 : 45,057

Data based on a survey of cotton compresses conducted by the Agricultural Marketing Service.

Table 7. - Cotton compressed, by type of compression, and by States and regions, season 1937-38

State and region	Gin bales compressed to --				Bales recompressed from --				Total standard density				Total high density				Total bales compressed			
	Standard density		High density		Standard density		High density		Standard density		High density		Standard density		High density		Standard density		High density	
	Bales	Pct.	Bales	Pct.	Bales	Pct.	Bales	Pct.	Bales	Pct.	Bales	Pct.	Bales	Pct.	Bales	Pct.	Bales	Pct.	Bales	Pct.
Southeast:																				
Alabama	54,821	24.4	154,869	68.9	14,945	6.7			54,821	24.4	169,814	75.6					224,635			
Florida	1,600	4.7	32,500	95.0	100	.3			1,600	4.7	32,600	95.3					34,200			
Georgia	48,634	33.9	87,804	61.2	6,263	4.3	806	0.6	49,440	34.5	94,067	65.5					143,507			
North Carolina	8,328	83.0	1,700	17.0					8,328	83.0	1,700	17.0					10,028			
South Carolina	19,987	18.3	87,671	80.2	1,700	1.5			19,987	18.3	89,371	81.7					109,358			
Virginia	484	5.1	8,970	94.9					484	5.1	8,970	94.9					9,454			
Total Southeast	133,854	25.2	373,514	70.3	23,008	4.3	806	.2	134,660	25.4	396,522	74.6					511,182			
Mississippi Valley:																				
Arkansas	887,205	79.5	221,940	19.9	6,675	.6			887,230	79.5	228,615	20.5					1,115,845			
Louisiana	508,737	32.7	726,784	46.8	312,799	20.1	25	1/	514,787	33.1	1,039,583	66.9					1,554,370			
Mississippi	1,608,514	85.1	256,239	13.5	26,465	1.4	6,050	.4	1,608,514	85.1	282,704	14.9					1,891,218			
Missouri	196,884	91.7	17,514	8.2	315	.1			196,884	91.7	17,829	8.3					214,713			
Tennessee	573,568	83.3	69,875	10.2	44,100	6.4	862	.1	574,470	83.4	113,975	16.6					688,405			
Total Mississippi Valley	3,774,908	69.1	1,292,352	23.6	390,354	7.2	6,937	.1	3,781,845	69.2	1,682,706	20.8					5,464,551			
Southwest:																				
Arizona	13,000	7.7	155,385	92.3					13,000	7.7	155,385	92.3					168,385			
California	114,000	15.4	627,731	84.6					114,000	15.4	627,731	84.6					741,731			
New Mexico	52,112	37.4	87,206	62.6					52,112	37.4	87,206	62.6					139,318			
Oklahoma	158,889	31.5	344,812	68.4	477	.1	148	1/	159,037	31.5	345,289	68.5					504,326			
Texas	191,078	4.5	3,782,980	89.7	239,861	5.7	4,235	.1	195,273	4.6	4,022,841	95.4					4,218,114			
Total Southwest	524,039	9.1	4,998,114	86.6	240,338	4.2	4,383	.1	533,422	9.2	5,238,452	90.8					5,771,874			
United States	4,437,801	37.7	6,663,980	56.6	653,700	5.6	12,126	.1	4,449,927	37.8	7,317,680	62.2					11,767,607			

Data based on a survey of cotton compresses conducted by the Agricultural Marketing Service.

1/ Less than 0.05 percent.

only a limited part of the cotton is compressed at all and where that which is compressed is intended for export, the major part of the compression is high density. In the Mississippi Valley, on the other hand, where a large proportion of the cotton goes to domestic mills, about 70 percent of the cotton is compressed to standard density. In the Southwest, where the bulk of the cotton is exported, less than 10 percent is compressed to standard density and more than 90 percent is compressed to high density. In the State of Texas, more than 95 percent is compressed to high density.

Only about 15 percent of the cotton compressed to standard density is recompressed to high density. In the Southwest, however, about half of the standard density cotton is recompressed to high density. A very small proportion of the bales originally compressed to high density are recompressed to standard density.

RATES CHARGED FOR COMPRESS SERVICES

Compression

Charges for compressing cotton usually are made on a per-bale basis, regardless of the weight of individual bales. During the season 1938-39, almost 80 percent of the cotton was compressed on this basis (table 8). Charges for the compression of the remainder of the cotton were made on a weight basis. All the cotton compressed in New Mexico and practically all of that compressed in Oklahoma was handled on a weight basis. Considerable cotton was compressed on this basis also in the States of Texas, California, and Tennessee.

Although there is considerable variation in rates charged for the compression of cotton, the customary rates over most of the Cotton Belt are 60 cents per bale for standard density and 75 cents per bale for high density (table 9). Rates are slightly higher in some of the Western States, particularly in Arizona and California. In most instances, the rate for standard-density compression is substantially lower than for high-density, because a greater number of bales can be compressed per hour and because other equipment and operating costs are less.

Rates vary somewhat for different sections of the country, depending primarily on competitive conditions and custom in each locality. Average rates have varied very little, however, during the 8-year period 1932-33 to 1939-40. The United States average rate for high-density compression has varied from a low of 72 cents per bale for the seasons 1935-36 and 1936-37 to a high of 78 cents per bale for the seasons 1933-34 and 1934-35. The United States average rate for the season 1939-40 was 77 cents per bale. Average rates for standard-density compression have varied from a low of 60 cents per bale for the 1936-37 season to 64 cents for the seasons 1934-35 and 1935-36.

Table 8. - Extent to which charges for compression of cotton are assessed on per-bale basis and on actual weight basis, by States, season 1938-39

State	Proportions of cotton compressed with charges assessed on --				
	Per-bale basis		Actual weight basis		
	Bales	Percent	Bales	Percent	
Alabama	201,819	89.8	22,816		10.2
Arizona	168,385	100.0			
Arkansas	1,060,820	95.1	55,000		4.9
California	551,731	74.4	190,000		25.6
Florida	34,200	100.0			
Georgia	142,701	100.0			
Louisiana	1,548,320	100.0			
Mississippi	1,828,849	96.7	62,369		3.3
Missouri	214,713	100.0			
New Mexico			139,318		100.0
North Carolina	10,028	100.0			
Oklahoma	1,882	.4	502,296		99.6
South Carolina	109,358	100.0			
Tennessee	565,770	82.3	121,773		17.7
Texas	2,762,449	65.6	1,451,430		34.4
Virginia	9,454	100.0			
Total	9,210,479	78.4	2,545,002		21.6

Data based on a survey of cotton compresses conducted by the Agricultural Marketing Service.

Receiving and Related Services

A number of services are performed by the compress industry that are incident to the compression and concentration of cotton. The basis of charging for these services is not standardized in the industry. Usually a flat per-bale charge is made for services associated with the receiving of the cotton. The items included in the receiving charge vary for different compresses but usually include the issuance of a warehouse receipt, weighing, sampling, marking, and from 5 to 30 days' storage. Average rates for these services have not varied materially during the 8-year period, 1932-33 to 1939-40, inclusive. The average rate for the United States was 23 cents per bale for the season 1939-40 (table 10). Some compresses do not make a receiving charge if they compress the cotton.

Table 9. - Average charges 1/ per bale for compressing cotton, by type of compression and by States, seasons 1932-33 to 1939-40, inclusive

State	1932-33	1933-34	1934-35	1935-36	1936-37	1937-38	1938-39	1939-40
	Standard: High	Standard: High	Standard: High	Standard: High	Standard: High	Standard: High	Standard: High	Standard: High
	Density: density	Density: density	Density: density	Density: density	Density: density	Density: density	Density: density	Density: density
	Cents: Cents	Cents: Cents	Cents: Cents	Cents: Cents	Cents: Cents	Cents: Cents	Cents: Cents	Cents: Cents
Alabama	61	76	75	70	75	60	59	61
Arizona	101	100	100	100	100	100	100	100
Arkansas	62	75	62	75	60	75	60	75
California	118	108	110	108	110	100	107	100
Florida	60	82	60	75	60	75	55	65
Georgia	60	75	60	75	60	82	50	65
Louisiana	68	75	65	75	47	61	63	68
Mississippi	61	75	61	75	60	75	60	75
Missouri	61	62	61	75	60	75	60	75
New Mexico	67	75	66	75	66	79	76	79
North Carolina	60	60	60	60	60	60	50	65
Oklahoma	66	75	77	62	59	76	76	76
South Carolina	60	75	75	75	60	75	56	65
Tennessee	62	75	61	60	60	75	60	75
Texas	68	72	68	62	64	71	75	76
Virginia	75	75	60	75	60	75	60	75
United States:	63	74	64	72	60	72	63	77

Based on published tariffs of commercial compresses.

1/ Rates quoted on a weight basis have been converted to a per-bale basis by using State average bale weights.

Table 10. - Average receiving charges 1/ per bale at cotton compresses, by States, seasons 1932-33 to 1939-40

State	'1932- '1933	'1933- '1934	'1934- '1935	'1935- '1936	'1936- '1937	'1937- '1938	'1938- '1939	'1939- '1940
	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
Alabama	34	32	30	30	30	35	31	30
Arizona	25	25	25	25	25	25	27	27
Arkansas	25	25	40	25	25	40	25	15
California	29	30	30	30	27	30	24	22
Florida	25	25	30	30	35	35	30	35
Georgia	16	26	29	25	35	30	34	37
Louisiana	25	20	30	30	25	41	32	28
Mississippi	25	25	36	31	25	40	32	28
Missouri	25	25	40	25	25	40	25	17
New Mexico	25	25	25	25	25	25	25	25
North Carolina	40	40	40	25	25	25	35	37
Oklahoma	15	15	15	15	15	15	15	15
South Carolina	28	40	26	25	25	25	27	35
Tennessee	25	25	40	25	25	40	25	15
Texas	25	22	39	21	21	22	27	23
Virginia	27	30	30	25	30	30	25	25
United States	24	23	35	25	24	31	27	23

Based on published tariffs of commercial compresses.

1/ Includes issuance of warehouse receipt, sampling, weighing, marking or tagging, and storage for periods varying from 0 to 30 days.

Storage

Although cotton is generally considered to be a non-perishable commodity, this is true only if it is protected from the weather. Cotton deteriorates fairly rapidly unless kept dry. Furthermore, because of its high inflammability, special precautions are required in the way of protection against loss from fire. Under these circumstances, the proper storage of cotton between the time it is ginned and the time it is delivered to cotton mills is a very important service, which is performed not only by compress establishments but by warehouses not providing compress facilities.

Rates charged for the storage of a bale of cotton are quoted either on a daily or on a monthly basis, depending somewhat upon local conditions and custom. As stated previously, the receiving charge generally includes a short period of storage. Usually the essential

services incident to concentration can be performed within that period. Regular storage rates become effective upon the termination of this period if the cotton is to be held in stock. In some instances, particularly in the Mississippi Valley States, a substantial reduction is made in rates after the cotton has been in storage for 60 or 90 days.

Average storage rates have varied little during the 8-year period 1932-33 to 1939-40. The United States average rates have varied from a high of 24 cents per bale per month for the seasons 1936-37 and 1937-38 to a low of 20 cents for the season 1939-40 (table 11). Recently, insurance coverage has been included with the charge for storage service and at the same time rates for storage have been reduced.

Table 11. - Storage rates for cotton: 1/ Average monthly charges per bale per month, by States, seasons 1932-33 to 1939-40, inclusive

State	1932- 1933	1933- 1934	1934- 1935	1935- 1936	1936- 1937	1937- 1938	1938- 1939	1939- 1940
	Cents	Cents	Cents	Cents	Cents	Cents	Cents	Cents
Alabama	21	22	20	20	20	24	22	23
Arizona	20	20	20	20	20	20	20	20
Arkansas	25	25	25	25	25	25	20	15
California	22	20	20	20	25	20	21	20
Florida	20	20	20	20	20	20	20	20
Georgia	20	22	20	20	20	20	21	22
Louisiana	25	12	18	18	23	24	22	20
Mississippi	25	25	24	25	25	25	22	19
Missouri	25	25	25	25	25	25	20	15
New Mexico	25	25	25	25	25	25	25	25
North Carolina	25	25	25	25	25	25	25	25
Oklahoma	15	15	15	15	15	15	15	15
South Carolina	26	25	27	25	25	28	26	25
Tennessee	25	25	25	25	25	25	20	15
Texas	24	21	25	23	25	24	22	23
Virginia	10	15	15	15	15	15	15	15
United States	23	21	23	22	24	24	21	20

Based on published tariffs of commercial compresses.

1/ For uncompressed cotton or for cotton for which no differential is provided for compressed cotton.

Since the space required for the storage of oompressed cotton is considerably less than that required for uncompressed cotton, some oompresses provide a differential rate for oompressed bales. For the season 1938-39, 56 oompresses, or 17 percent of the active establishments, charged lower rates for the storage of compressed bales than for flat bales (table 12). As a general rule, those establishments which do not provide a differential rate either follow the polioy of oompressing all ootton upon arrival or reserve the right to oompress the ootton in the event of a shortage of storage space.

Table 12. - Extent to which oompresses provide differential rates for storage of oompressed and uncompressed cotton and average rates for each, by States, season 1938-39

State	Compresses with storage rate --				Average storage	
					rate per bale	
					per month <u>1/</u>	
	Same for flat and		Differential for		Com-	Unoom-
	oompressed bales		oompressed bales		pressed	pressed
					cotton	cotton
	Compresses	Percent	Compresses	Percent	Cents	Cents
Alabama	8	53.0	7	47.0	17	22
Arizona			2	100.0	15	20
Arkansas	35	100.0				
California			6	100.0	15	21
Florida			2	100.0	15	20
Georgia	4	27.0	11	73.0	15	20
Louisiana	31	100.0				
Mississippi	52	98.0	1	2.0	18	24
Missouri	6	100.0				
New Mexico	2	100.0				
North Carolina ...			2	100.0	20	25
Oklahoma	26	100.0				
South Carolina ...	5	71.0	2	29.0	22	32
Tennessee	15	100.0				
Texas	95	81.0	23	19.0	17	30
Virginia	1	100.0				
United States ..	280	83.0	56	17.0	17	24

Based on published tariffs of commercial oompresses.

1/ Includes only presses quoting differential rates.

DISTRIBUTION OF COTTON FROM COMPRESSES

Each cotton compress has been located to serve, and usually does serve, a fairly well defined cotton-producing area. Under competitive conditions, however, there is considerable overlapping of territories served by individual compresses located at interior points as well as at ports.

The distribution of cotton from interior compress points conforms to a different and, in each instance, rather distinct pattern for compresses located in each of the three major cotton-producing regions. In the Southeast, about 90 percent of the cotton from compresses goes direct to domestic mill points (table 13). The remainder goes to ports. In Alabama, a larger proportion of the cotton goes to ports than is the case for other Southeastern States.

In the Southwest, about 90 percent of the cotton is shipped to ports. Slightly less than 10 percent is shipped direct to domestic mill points and a negligible part goes to other interior concentration points.

Shipments of cotton from interior compress points in the Mississippi Valley States are somewhat more diverse than those in the other two regions. Almost 58 percent of the cotton is shipped direct to domestic mill points. About 29 percent is shipped to ports and nearly 13 percent goes to interior concentration points.

Most of the cotton shipped from interior compresses to domestic mill points moved on a 50,000-pound carloading, which is required for the lowest available rail freight rates to such destinations. In the Southeast, however, where the cotton moved relatively short distances to mill destinations, about 38 percent was shipped in less than carload lots, and 16 percent was transported by trucks.

In the Southwest, where most of the cotton was shipped to ports, the major portion moved by rail on a 65,000-pound loading, which now provides the lowest available rate to ports and for which high-density compression usually is required.

Cotton shipped from compresses in the Mississippi Valley to interior concentration points was practically all shipped by rail in less than carload lots. A limited quantity was moved to such destinations by truck.

The carloadings used in the shipment of cotton from compress points to various types of destinations vary to some extent on a regional basis to conform with regional differences in the freight-rate structure for cotton. This is particularly true with respect to the various carload minima to which a graduated scale of rates apply.

Table 13. - Shipments of cotton from interior compress points in specified States and regions to interior concentration points, mill points, and ports: Percentage distribution by type of destination, mode of transportation, and loading used, season 1937-38

Type of destination, mode of transportation, and loading used	Shipments from compress points in --															
	Southeast								Mississippi Valley							
	Ala.	Fla.	Ga.	N. C.	S. C.	Ark.	La.	Miss.	Mo.	Tenn.	Total	Ariz.	Calif.	N. M.	Okl.	Tex.
Interior concentration points:	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rail:																
Less than carload lots																
25,000 pounds							15.6	0.5	15.8	40.4	3.9	11.8				0.5
50,000 pounds							1				1/					
Truck							4	1.2			3					1
Total							24				3					3
Mill points:																
Rail:																
Less than carload lots																
25,000 pounds																
35,000 pounds																
37,500 pounds																
50,000 pounds																
65,000 pounds																
Rail and water																
Truck																
Total																
Ports:																
Rail:																
Less than carload lots																
37,500 pounds																
47,500 pounds																
50,000 pounds																
65,000 pounds																
75,000 pounds																
Truck																
Total																
All destinations																

Data based on a survey of cotton compresses conducted by the Agricultural Marketing Service.

1/ Less than 0.05 percent.

DIMENSIONS AND DENSITIES OF COTTON BALES

Although the length and width dimensions of gin press boxes are standardized in this country at 54 inches by 27 inches, there are substantial variations in the dimensions of the bales as turned out at gins. The variation in dimensions of individual bales is even more pronounced after the bales have been compressed.

Square bales of cotton after tying out at gins vary in length from 54 inches to 58 inches, as measured with bale calipers. The width dimension varies from 27 inches to 30 inches. As would be expected, the thickness of the bales varies more than either of the other two dimensions. The range is from 40 inches to 50 inches. These variations in dimensions are attributable to the condition of the side and end doors of presses, the manner in which the bales are tied out, and more particularly, the weight of the individual bales.

The density of square gin bales averages about 13 pounds per cubic foot and varies from about 8 to 18 pounds. The density of the bales varies directly with bale weights (table 14).

The average dimensions of standard-density bales are approximately 56 inches in length, 30 inches in width, and 22 inches in thickness. The range in density is from 15 pounds to 29 pounds per cubic foot, with an average of 24 pounds. Usually a minimum of 22.5 pounds per cubic foot is required by transportation companies for bales of this type.

High-density bales average about 57 inches in length, 22 inches in width, and 22 inches in thickness. The range in length is from 56 to about 60 inches. The width of the bales varies from 21 to 24 inches. The distances between the side doors of high-density presses vary materially as between individual presses. In most instances, this distance is 20 inches, but the range is from about 18 to 22 inches. The thickness dimension of high-density bales varies from about 20 inches to 25 inches.

The average density for high-density bales is about 33 pounds. The density of these bales varies directly with the weight of the bales from about 22 pounds for light-weight bales to more than 40 pounds for extra-heavy bales. The minimum requirement of transportation companies for bales of this type is usually 32 pounds per cubic foot.

The tied-out dimensions of bales of various types depend not only on the manner in which the ties are attached but to some extent also on the number of ties used. Six ties are universally used on gin bales. For standard-density bales, the number used varies from

Table 14. - Average dimensions and densities of cotton bales, by weight and by type of bale

Bale weight (pounds)	T Y P E O F B A L E											
	Flat gin bales				Compressed bales							
	Standard density				High density							
	Length: Inches	Width: Inches	Thick- ness	Density	Length: Inches	Width: Inches	Thick- ness	Density	Length: Inches	Width: Inches	Thick- ness	Density
	per cu. ft.	per cu. ft.	per cu. ft.	per cu. ft.	per cu. ft.	per cu. ft.	per cu. ft.	per cu. ft.	per cu. ft.	per cu. ft.	per cu. ft.	per cu. ft.
380 and under	57.0	28.5	44.0	8.1	57.0	30.0	23.0	14.8	58.3	21.0	21.3	22.6
381 - 400	57.0	28.0	48.0	8.8	58.0	32.0	20.0	17.3	56.5	21.2	21.0	26.9
401 - 420	56.0	27.8	44.3	10.3	56.7	30.7	21.0	19.4	56.6	21.3	20.6	28.6
421 - 440	56.3	28.8	43.9	10.4	56.7	30.0	21.0	20.8	57.4	21.6	20.5	29.3
441 - 460	56.0	28.5	43.2	11.3	57.0	30.6	20.2	22.1	57.3	21.5	21.6	29.2
461 - 480	55.9	28.5	43.8	11.6	56.4	30.4	20.8	22.8	56.7	21.7	21.3	31.0
481 - 500	55.9	28.5	43.6	12.2	56.6	30.5	21.2	23.2	56.7	22.1	21.2	32.0
501 - 520	55.9	28.5	43.8	12.6	56.6	30.6	21.4	23.8	56.8	22.2	21.5	32.6
521 - 540	56.0	28.4	43.9	13.1	56.6	30.4	21.8	24.4	57.0	22.2	22.2	32.7
541 - 560	56.0	28.5	44.9	13.3	56.4	30.6	21.9	25.2	56.8	22.5	22.6	33.0
561 - 580	55.9	28.6	45.4	13.6	56.4	30.9	22.3	25.4	57.0	22.5	22.4	34.2
581 - 600	56.3	28.5	45.6	13.9	56.5	31.0	22.3	26.1	56.8	22.6	23.4	34.0
601 - 620	56.0	28.6	45.6	14.4	56.5	30.8	23.1	26.2	57.5	23.0	23.2	33.6
621 - 640	56.2	28.3	47.7	14.4	57.0	30.7	22.8	27.3	57.2	23.1	23.5	35.0
641 - 660	56.0	28.5	47.0	15.0	57.0	29.0	25.0	27.2	57.8	23.6	23.8	34.6
661 - 680	55.0	28.0	46.0	16.0					58.0	23.0	23.5	37.0
681 - 700	55.0	27.0	44.0	18.3	56.0	29.0	25.0	29.4	56.0	24.0	25.0	35.5
701 and over	56.0	29.0	46.0	16.4					56.0	23.0	23.7	41.3
All weights	56.0	28.5	44.4	12.9	56.5	30.6	21.8	24.5	56.9	21.9	22.1	33.2

Data based on caliper measurements and compress weights.

7 to 9. More than three-fourths of the bales, however, carry 8 ties (table 15). Nine ties are used only to a very limited extent on standard-density bales. Almost 96 percent of the high-density bales carry 9 ties. Only 8 ties are used in some instances, and occasionally 10 or more ties are used. Usually the additional ties used on compressed bales are obtained by reworking and splicing the segments out from the ties removed from gin bales, when they are reduced in length, for use on compressed bales.

Table 15. - Number of ties used on compressed bales, by type of bale and by States, season 1937-38

State	Standard-density bales			High-density bales			
	7	8	9	8	9	10 or	
	ties	ties	ties	ties	ties	more	
	ties	ties	ties	ties	ties	ties	
	Bales	Bales	Bales	Bales	Bales	Bales	Bales
Alabama	8,801:	46,020:		9,680:	160,134:		
Arizona		13,000:			155,385:		
Arkansas	247,663:	639,542:		30,673:	197,681:	261	
California		114,000:		32,800:	594,931:		
Florida		1,600:		16,000:	16,600:		
Georgia		48,634:		3:	94,064:		
Louisiana	29,492:	479,245:			1,039,583:		
Mississippi	579,413:	973,309:	55,792:	12,884:	266,928:	2,892	
Missouri	57,915:	138,969:			17,829:		
New Jersey							
New Mexico		52,112:			87,206:		
North Carolina ...:		8,328:			1,700:		
Oklahoma		158,889:		10,864:	334,220:	205	
South Carolina ...:		19,987:		36,550:	47,771:	5,050	
Tennessee	27,112:	546,456:		2,866:	87,123:	23,986	
Texas	6:	190,505:	527:	82,702:	3,896,521:	43,618	
Virginia	474:	10:			8,970:		
All States	950,876:	3,430,606:	56,319:	235,022:	7,006,646:	76,012	
Percent	21.4 :	77.3 :	1.3 :	3.2 :	95.8 :	1.0	

Data based on a survey of cotton compresses conducted by the Agricultural Marketing Service.

SPECIAL PROBLEMS ASSOCIATED WITH COMPRESSION

Cutting of Bales During Compression

For a number of years both domestic and foreign spinners have complained of the presence of cuts of varying degrees of severity in compressed bales of American cotton. These have been commonly referred to as "air cuts" on the assumption that they are caused by the rapid expulsion of air when pressure is suddenly applied to the bales in compressing them. It has been assumed also that these cuts reduce the spinning value of the cotton.

Just when the phenomenon of cutting of bales during compression was first observed is not definitely known. It has been a subject of discussion, however, for a number of years. That it was recognized as a problem as far back as 1910 is evidenced by the fact that in that year a patent was granted by the U. S. Patent Office on an invention designed to eliminate such cuts. It is interesting to note that this invention, which consisted of a provision for housing the press in a huge vacuum cylinder and for removing all the air before compression, was based on the theory that the cuts were caused by the too rapid expulsion of air from the bales.

During recent years the problem of cutting has received constantly increasing attention in the cotton industry. That it is attracting considerable attention at present is perhaps due to a combination of circumstances. The recent tendency to use lighter patches and, in some instances, to compress bales without patches, has made the cuts more apparent than formerly was the case. In some instances, spinners have rejected bales containing severe cuts.

At the 18th International Cotton Congress held in Egypt in 1938, a resolution dealing with this problem was adopted. The text of the resolution is as follows:

"That this Congress views with concern the growing prevalence of air-cut bales emanating chiefly from South Brazil and U. S. A., these being caused by too rapid pressing of bales in conjunction with higher densities. These air-cut bales are a serious loss and trouble to spinners as untold millions of fibers in such bales are cut and rendered useless. This Congress requests that all concerned should take steps to end a practice which is bringing otherwise good cotton into disrepute and suggests that experiments be undertaken by the Brazilian and U. S. A. Governments to discover a safe speed in pressing the bale."

Extent and importance of cutting. - A preliminary survey disclosed the fact that cutting during compression is prevalent in all parts of the Cotton Belt. Intensive studies at 16 representative compresses located in various parts of the country, including detailed observations on the compressing of about 25,000 bales of cotton, indicate that approximately 35 percent of the bales compressed are out to some extent (fig. 3). The percentage of bales out varies greatly for individual compresses. At some compresses a very small proportion of the bales observed during compression were out, while some compresses out more than one-half of the bales compressed.

The degree of cutting varied materially from bale to bale. Some of the slight outs were only an inch or two long and about one-half inch deep. At the other extreme were the severe cuts which, in some instances, were 12 inches or more in length and 12 inches or more deep. The number of cuts in a bale varied from a single cut to as many as 20.

The outs cause inconvenience and loss of time to compresses. In some instances, portions of the out cotton become jammed in the tie channels and have to be forced out with iron bars before proceeding with the compression of the next bale. Some of the cuts along the edges of the bales are so severe that it is necessary for the compress crew to stop operations and rebuild the bale in order to remedy the ragged appearance. These interruptions in the normal operation of the press increase the cost of compression.

The extent to which the cutting of bales during compression reduces the spinning value of the cotton has been a subject of considerable controversy in the cotton industry. In order to provide a definite answer to this question, bales were selected representing the maximum severity of cutting observed. Laboratory spinning tests were made on the out cotton from these bales in comparison with cotton of identical quality not affected by cutting.

The results of these tests indicate a perceptible but not important increase in spinning waste in the case of bales out during compression. The manufacturing performance of such cotton and the appearance and strength of the yarn are slightly less satisfactory than for cotton of the same quality from bales not out. 6/

6/ These spinning tests were conducted at the Department's Spinning Laboratory at College Station, Tex., by R. L. Lee, Jr., and associates under the supervision of M. E. Campbell.



FIGURE 3. - COTTON BALES CUT DURING COMPRESSION.

These photographs represent rather extreme cases of bale cutting.

Although the effect of cutting on the spinning value of the cotton may be considered almost negligible, the damage to the bale package, the psychological effect on cotton merchants and spinners particularly in foreign countries where other growths of cotton are competitive with American, and the extra trouble and loss of time caused the compress industry, justify a concerted effort to eliminate such cutting. With this end in view, an attempt has been made to discover the cause or causes of cutting during compression and practical means for its elimination.

Theories of cutting. - A preliminary survey of the cotton compress industry which was conducted at the beginning of work on this problem, disclosed a long list of theories relative to the cause of cutting cotton bales during the process of compression (table 16). These theories may be grouped into a relatively few principal categories including the manner in which the bales are packed at gins, the condition of the cotton, mechanical features of presses, techniques of press operation, the character of the cotton, and kind of bagging and patches used on the bales.

Perhaps the theory of cutting most frequently advanced, at least outside of the compress industry, is the so-called "air" theory. According to this theory, air pockets become so highly compressed that the air shears the cotton in escaping from the bale.

Many compress operators are of the opinion that the manner in which the bales are packed at gins is a factor in cutting. The specific features of gin packing to which cutting is attributed are: "dog-ridges" -- a term applied to the relatively dense portions of the bale accumulated under the "dogs" of the gin press box; big-ended and heavy-sided bales resulting from defective operation of gin condensers, kicker mechanisms and trampers; and extra-heavy bales.

A substantial proportion of compress operators expressed the opinion that the condition of the cotton is an important factor in cutting. The opinion was expressed that cutting is associated with green, damp, and wet cotton. On the other hand, some expressed the opinion that excessively dry and spongy cotton is especially subject to cutting during compression.

Some compress operators believe that cutting is associated with the character of the cotton. Cotton of soft, immature, short, or perished staple is believed to be more subject to cutting than cotton of long staple and sound character.

Table 16. - Theories of bale cutting during compression as advanced by compress operators and relative importance of each

Bale cutting thought to be attributable to --		Compress operators advancing theory <u>1/</u>	
		Number	Percent
Gin packing	228	:	70.4
Big-ended or heavy-sided bales	176	:	54.3
Dog ridges	6	:	1.9
Heavy bales	45	:	13.9
Sand and trash pockets	1	:	.3
Condition of cotton	95	:	29.3
Green or damp cotton	58	:	17.9
Wet cotton	19	:	5.9
Dry cotton	2	:	.6
High humidity	16	:	4.9
Mechanical features of press	18	:	5.6
Platens out of alinement	13	:	4.0
Sharp channel bars	4	:	1.2
Band channels too wide	1	:	.3
Technique of press operation	67	:	20.7
Pressing too fast	45	:	13.9
Excessive steam pressure	18	:	5.6
Bales not properly placed in press	4	:	1.2
Character of cotton	39	:	12.0
Soft cotton	3	:	.9
Spongy cotton	2	:	.6
Perished staple	3	:	.9
Short staple	9	:	2.8
Bollies	2	:	.6
Rough-ginned cotton	9	:	2.8
Trashy or low-grade cotton	11	:	3.4
Bagging	20	:	6.2
Weak bagging	5	:	1.5
Light-weight bagging	4	:	1.2
No patches	9	:	2.8
Close-woven fabric	1	:	.3
Wide-mesh fabric	1	:	.3
Excessive sampling	7	:	2.2
No theories	41	:	12.7

Data based on a survey of cotton compresses conducted by the Agricultural Marketing Service.

1/ Many compress operators advanced more than one theory.

About 20 percent of the compress operators attribute cutting wholly or in part to mechanical features of presses or to techniques of operation. Among the mechanical features that have been mentioned in this connection are worn channel bars, wide tie channels, and upper and lower press platens out of alignment. Techniques of operation to which cutting is attributed are: excessive pressure, failure properly to place bales in the press, pressing too fast, and lack of skill in lever operation.

Only a minority of compress operators attribute cutting to type or quality of bagging used for covering bales. Excessively weak or light-weight bagging usually were mentioned in this connection. It is of interest to note, however, that practically all types of bagging now in use were cited as being either wholly or partially responsible for cutting during compression.

Investigations of causes of cutting. - Although it was obvious that some of the theories advanced as an explanation of cutting during compression were more tenable than others, consideration has been given to all of them in an attempt to ascertain the specific cause or causes of cutting. Insofar as possible each theory has been subjected to critical testing both under controlled conditions and under regular operating conditions at commercial compresses. In each instance, statistical analyses of data based on detailed observations have been made to ascertain relationships of various factors to the phenomenon of cutting during compression.

Air theory. - The so-called "air" theory of cutting is based on the assumption that pockets of air within the bale become so highly compressed that the cotton is sheared as the air escapes. This theory is not very tenable in view of the fact that if air is compressed adiabatically (without loss of heat) to a pressure of 2,000 pounds per square inch, which is approximately the pressure exerted in compressing the cotton, the volume of any trapped quantity of air would be reduced to 0.003 of its original volume and the temperature would increase to about 2,150° F. This, of course, is far above the kindling temperature of cotton.

In an attempt to verify this theory, provision was made for inserting in bales of cotton, before compression, a relatively large quantity of air in a suitable container, so as to observe the action of the confined air during the compression of the bales. It was found, after some experimentation, that a football provided the most suitable container for this purpose. The footballs, in the case of each test, were inflated to a pressure of approximately 5 pounds per square inch and placed in the flat gin bales. When pressure was applied during compression, the footballs burst at varying times prior to attaining maximum density. In each instance, however, it

was observed that the air from the footballs escaped horizontally through the layers of cotton and that no outs were produced by the escaping air. The air in passing out through the layers of cotton produced a slight opening of rough circular appearance as contrasted with the smooth vertical outs that characterize the outs made during regular compression. In one instance, the air was retained in the football sufficiently long before bursting to develop enough heat from compression to burn some of the cotton in the path of its escape.

Speed of compression. - The theory has been advanced that the speed with which the lower platen of the compress rises on the bale is a factor in cutting. According to the proponents of this theory, excessive speed in operating the press is the cause of cutting. This theory is closely related to the "air" theory in the assumption that air pockets exist in the bales and that excessive speed in compressing them gives less opportunity for the entrapped air to escape before becoming so highly compressed as to cause cutting when it does escape. It has been suggested also that a too rapid readjustment of the fibers in the bale accompanying high-speed compression is the cause of cutting.

An investigation of this theory was made by timing with a stop watch, the ascent of the press platen (ram speed) during the compression of several thousand bales at a number of different compresses operating under usual commercial conditions but representing considerable variation in speed of compression. The bales were observed in each instance for outs. A statistical analysis of the results failed to disclose any consistent relationship between speed and cutting of bales. As a matter of fact, the unadjusted results indicate that the percentage of bales out tends to vary inversely with speed of compression; that is, more cutting sometimes takes place at the slower speeds (table 17). This is explained, however, by an analysis of the relationship of speed of compression to the weight of the bales being compressed. The ascent of the press platen is consistently slower in the case of the heavier bales (table 18). When an adjustment is made for the higher percentage of cutting in the case of the heavier bales, the effect of speed of compression on cutting appears to be negligible.

Table 17. - Relation of cutting of cotton bales to speed of compression, by type of compression

Speed of compression (seconds)	Percent of bales out	
	Standard-density compression	High-density compression
	<u>Percent</u>	<u>Percent</u>
5.0 and under	26	39
5.1 to 10.0	29	55
10.1 to 15.0	23	66
15.1 to 20.0	15	69
20.1 to 25.0		50
25.1 to 30.0	8	50
30.1 to 35.0	17	50
35.1 and over	0	50

Data based on observations made at commercial cotton compresses.

Table 18. - Relation of speed of compression to weight of bales, by type of compression

Weight of bales (pounds)	Average ram speed	
	Standard density	High density
	<u>Seconds</u>	<u>Seconds</u>
380 and under	5.4	4.7
381 - 400	5.7	4.9
401 - 420	5.0	5.0
421 - 440	5.6	5.2
441 - 460	5.1	5.3
461 - 480	5.5	5.4
481 - 500	5.4	5.5
501 - 520	5.4	5.4
521 - 540	5.5	5.4
541 - 560	5.6	5.6
561 - 580	5.9	6.0
581 - 600	5.9	6.5
601 - 620	6.4	8.1
621 - 640	8.7	7.8
641 - 660	7.5	8.2
661 - 680	7.5	8.7
681 - 700	7.5	7.4
701 and over	7.5	8.7

Data based on observations made at commercial cotton compresses.

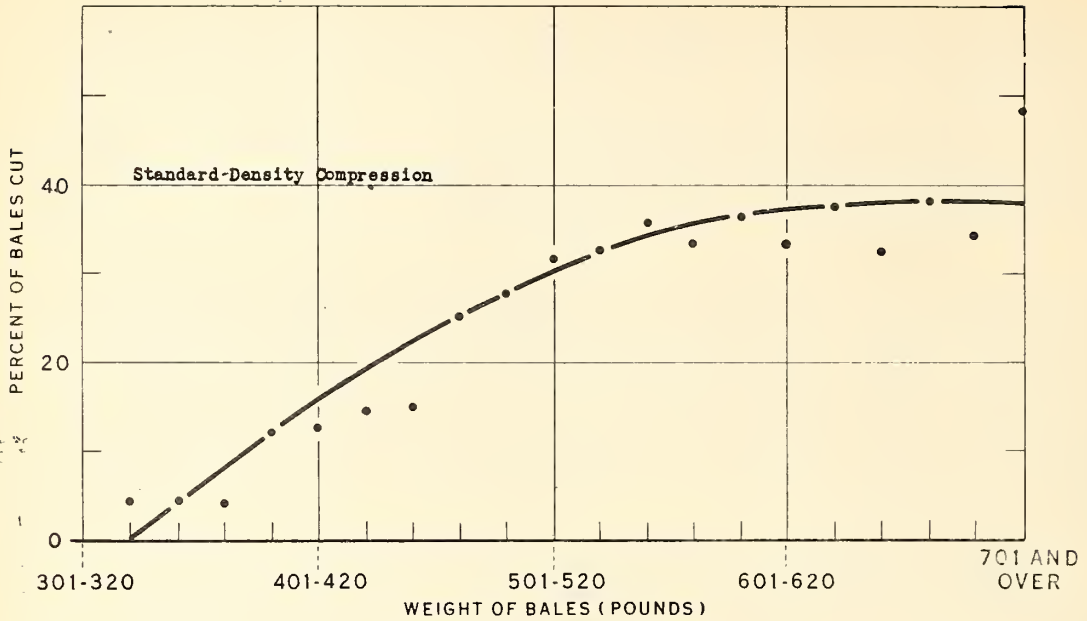
Weight of bales. - Detailed observations of the cutting during the compression of a large number of bales disclosed a definite relationship between the weight of the bales and cutting. The percentage of bales cut varies directly with the weight of the bales (fig. 4 and table 19). Most of the cutting takes place in the extra-heavy bales. This was found to be the case for all compresses at which observations were made as well as for cotton packed at different gins.

The higher percentages of cutting shown for bales compressed to high density than for bales of the same weight groups compressed to standard density, are partially accounted for by the fact that most of the observations of high-density compression were made in dryer climates than those prevailing where the observations of standard-density compression were made. The effect of the moisture content of cotton on cutting is discussed under the heading "Moisture content of the cotton."

Density attained. - The opinion has been expressed that the cutting of bales is attributable primarily to the density attained in the process of compression. Obviously, the density to be taken into account in a consideration of this theory is the maximum density attained while the bales are in the press rather than the density of the bales after they are tied out and the pressure on the press platen has been released.

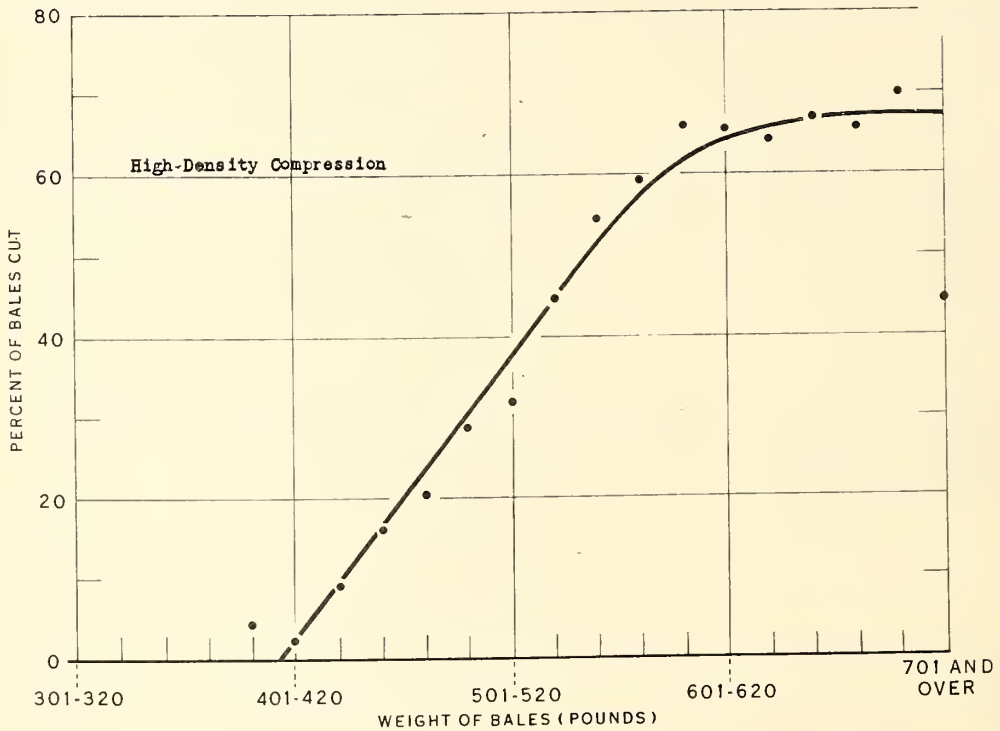
The maximum density attained during the compression of a bale is determined by the weight of the bale and the minimum separation of the upper and lower platens of the press at the end of the upward stroke of the lower platen. Perhaps this can best be expressed in terms of the number of pounds of cotton per inch of distance between the press platens when the minimum separation of such platens has been attained.

Data based on a large number of observations indicate some relationship between density attained and cutting (table 20). This relationship, however, is not particularly pronounced and does not appear to be consistent for individual compresses.



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FIGURE 4. - RELATIONSHIP OF WEIGHT OF COTTON BALES TO CUTTING DURING COMPRESSION.

Cutting varies directly with the weight of the bales for both standard-density and high-density compression. Data for standard-density compression are based on observations of approximately 20,000 bales and for high-density compression on about 5,000 bales.

Table 19. - Relationship of weight of cotton bales to cutting during compression, by type of compression

Weight of bales (pounds)	Percent of bales cut during compression to --	
	Standard	High
	density	density
	Percent	Percent
321 - 340	4.2	:
341 - 360	4.2	:
361 - 380	4.1	:
381 - 400	12.1	4.2 ^{1/}
401 - 420	12.6	2.2
421 - 440	14.4	9.1
441 - 460	15.0	15.9
461 - 480	24.9	20.3
481 - 500	27.4	28.7
501 - 520	31.6	31.8
521 - 540	32.7	44.7
541 - 560	35.7	54.5
561 - 580	33.3	59.1
581 - 600	36.2	65.8
601 - 620	33.4	65.5
621 - 640	37.5	64.1
641 - 660	32.3	66.7
661 - 680	38.1	65.4
681 - 700	34.2	70.0
701 and over	48.4	44.4

Data based on observations at commercial cotton compresses.

^{1/} Includes all bales 400 pounds and under.

Table 20. - Relationship of cutting of cotton bales to density attained during compression, by type of compression

Pounds of cotton per inch of distance between compress platens <u>1/</u>	Percent of bales cut during compression	
	Standard	High
	density	density
	Percent	Percent
26 - 30	<u>2/</u>	10.0
31 - 35	0.0	17.0
36 - 40	0.0	26.9
41 - 45	10.3	49.7
46 - 50	35.8	61.4
51 - 55	33.3	41.5
56 - 60	29.8	57.1
61 - 65	44.7	50.0
66 - 70	70.0	<u>2/</u>

Based on observations made at commercial cotton compresses, seasons 1938-39 and 1939-40.

1/ Bale weight divided by distance between upper and lower platens of compress when maximum density has been attained.

2/ No data available.

It is of interest to note that the minimum separation of the press platens is rather definitely related to the weight of the bales. The distance between the upper and lower platens when maximum density has been attained varies directly with the weight of the bales being compressed (table 21). It will be noted, however, that for the various weight groups, the density of the cotton as reflected by distance between compress platens, is not materially different for the bales cut and those not cut. As a matter of fact in some instances the density of the cut bales was less than that of bales not cut.

Table 21. - Relation of minimum separation of compress platens to weight of bales, by type of compression

Weight of bales (pounds)	Minimum separation of compress platens						
	Standard-density			High-density			
	compression			compression			
	All	Bales	Bales	All	Bales	Bales	
	bales	out	not out	bales	out	not out	
	Inches	Inches	Inches	Inches	Inches	Inches	
380 and under.	8.2		8.2	11.7	12.5	11.7	
381 - 400	9.1		9.1	12.1		12.1	
401 - 420	8.4		8.4	12.0	12.5	12.0	
421 - 440	8.7	8.5	8.7	12.0	11.9	12.0	
441 - 460	8.6	8.3	8.6	12.2	12.2	12.2	
461 - 480	9.0	9.0	9.0	12.2	12.2	12.2	
481 - 500	9.3	9.5	9.2	12.4	12.4	12.4	
501 - 520	9.4	9.4	9.4	12.6	12.6	12.6	
521 - 540	9.8	9.6	10.0	12.7	12.8	12.7	
541 - 560	10.1	10.0	10.2	13.1	13.1	13.1	
561 - 580	10.5	10.3	10.6	13.4	13.4	13.4	
581 - 600	11.2	11.0	11.3	13.6	13.6	13.6	
601 - 620	11.5	11.1	11.7	13.9	13.9	14.0	
621 - 640	12.4	11.7	13.0	14.3	14.2	14.4	
641 - 660	12.3	10.5	12.5	14.4	14.4	14.4	
661 - 680	13.0	13.5	12.9	14.8	14.4	15.4	
681 - 700	13.0	13.5	12.5	14.6	14.3	15.0	
701 and over	13.3	13.2	12.5	15.0	15.1	15.0	

Data based on observations made at commercial cotton compresses.

Similarly, the data relative to tied-out densities of the bales do not indicate a very definite relationship between cutting and density (table 22). An analysis of the available data by individual compresses discloses the significant fact that some compresses that obtained a relatively high average density did not cut as large a proportion of bales compressed as did compresses that obtained a relatively low average density for bales compressed.

Table 22. - Relation of density obtained to outting of cotton bales during compression, by type of compression

Density of cotton (pounds per cubic foot)	Percent of bales out	
	Standard-density	High-density
	compression	compression
	<u>Percent</u>	<u>Percent</u>
19	50.0	
20	66.7	
21	50.0	
22	58.3	
23	66.7	
24	44.4	0.0
25	27.3	0.0
26	40.0	0.0
27	100.0	20.0
28		23.8
29		30.0
30		25.0
31		26.5
32		27.7
33		27.6
34		55.2
35		50.0
36		44.4
37		57.1
38		16.7
40 and above		0.0

Data based on observations made at commercial cotton compresses, season 1939-40.

There is a definite tendency for the density of the bales to vary directly with weight. Consistently higher densities are obtained with the heavier bales (table 23).

Table 23. - Relation of density obtained in compression to weight of bales, by type of compression

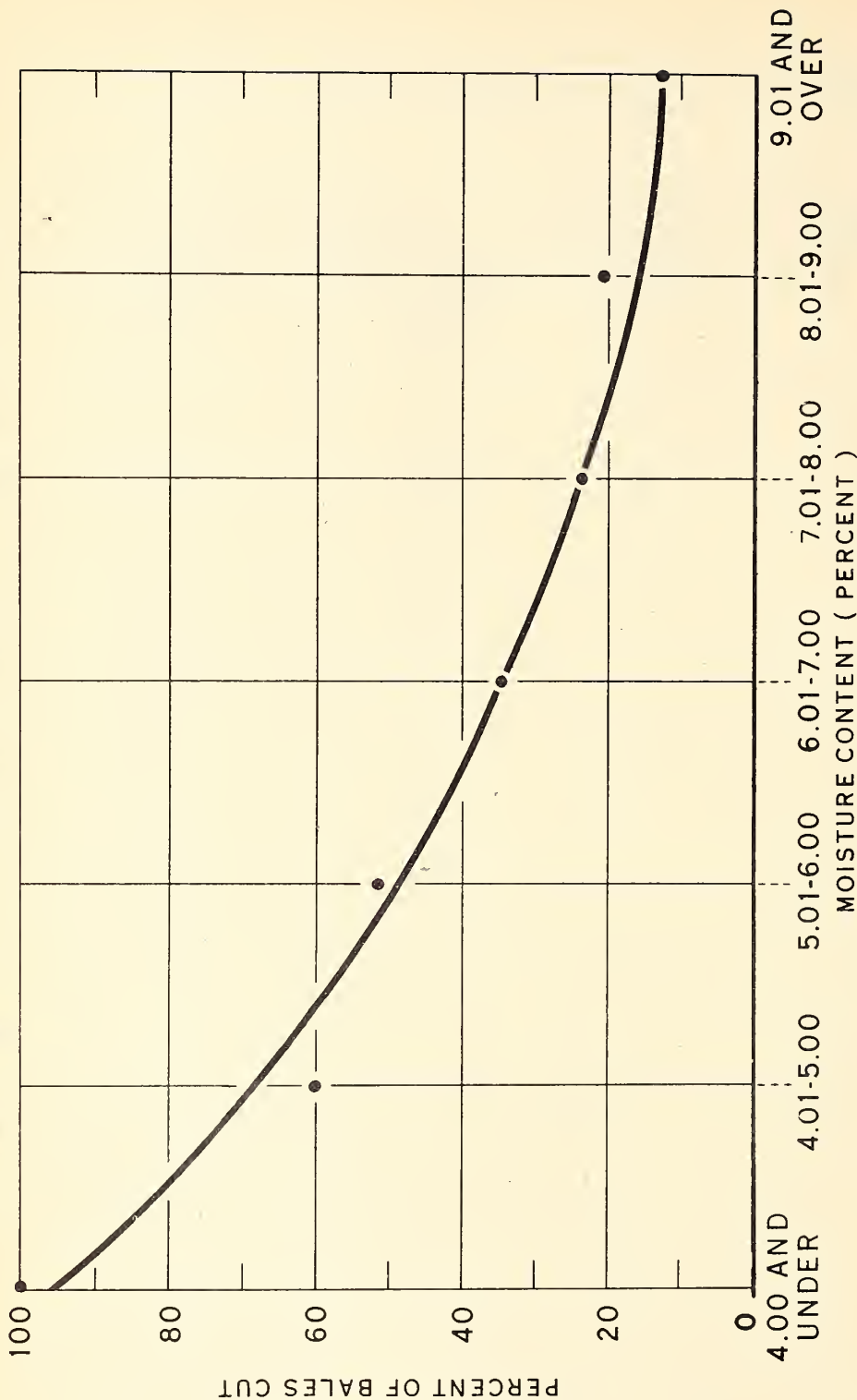
Bale weight (pounds)	Density of cotton (pounds per cubic foot)	
	Standard-density	High-density
	compression	compression
	Pounds	Pounds
380 and under	1/ ---	20.0
381 - 400	---	27.7
401 - 420	19.5	27.9
421 - 440	22.0	28.4
441 - 460	22.5	28.8
461 - 480	22.9	30.2
481 - 500	23.1	30.6
501 - 520	24.2	31.9
521 - 540	24.4	32.2
541 - 560	---	33.4
561 - 580	---	34.2
581 - 600	---	34.4
601 - 620	---	34.5
621 - 640	---	33.8
641 - 660	---	33.0
661 - 680	---	38.0
681 - 700	---	---
701 and over	---	40.0

Data based on weights and caliper measurements at commercial compresses.

1/ Three dashes indicate that no data are available.

Moisture content of the cotton. - The percent of bales out during compression varies with the moisture content of the cotton in the bales. Contrary to popular opinion, however, there is more cutting in dry cotton than in damp or wet cotton (fig. 5). The percent of bales out during compression varies inversely with the percent of moisture in the cotton (table 24). A relatively small proportion of the bales having a moisture content of 7 to 9 percent were out during compression. The fact that bales having a low moisture content usually are out is explained by the fact that greater pressure must be applied to obtain a given density if the cotton is very dry. This was verified by instrument recordings of hydraulic and platen pressures during the compression of bales of known moisture content. Tests at the U. S. Cotton Ginning Laboratory have consistently shown increases in hydraulic and platen pressures accompanying decreases in the moisture content of the bales. The increase in pressure is almost 50 percent on dry as compared with wet cotton (table 25).

RELATIONSHIP OF MOISTURE CONTENT OF COTTON TO BALE CUTTING DURING COMPRESSION



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FIGURE 5. - RELATIONSHIP OF MOISTURE CONTENT OF COTTON TO BALE CUTTING DURING COMPRESSION.

Cutting varies inversely with the moisture content of the cotton.

Table 24. - Relationship of moisture content of cotton to bale outting during compression

Moisture content (percent)	Percent of bales out
4.00 and under	100.0
4.01 - 5.00	60.0
5.01 - 6.00	51.2
6.01 - 7.00	34.7
7.01 - 8.00	23.6
8.01 - 9.00	20.4
9.01 and over	12.5

Data based on compress observations and laboratory moisture determinations on samples taken from bales compressed.

Table 25. - Influence of moisture content of cotton on hydraulic and platen pressures required to press bales of specified types (averages)

Type of bale and moisture designation of cotton	Moisture content of cotton	Hydraulic pressure	Platen pressure on cotton (calculated)	Minimum bale weight	Platen separation	Cotton per inch of platen separation
	Percent	Lb. per sq. in.	Lb. per sq. in.	Pounds	Inches	Pounds
Flat bales:						
Wet	8.5	648	31	469	32.5	14.4
Damp	7.6	815	40	498	33.6	14.8
Dry	6.2	1,048	51	501	32.9	15.2
400-pound gin high-density bales:						
Wet	8.8	2,110	574	376	20.0	18.8
Damp	8.0	2,174	591	387	21.1	18.3
Dry	6.4	3,396	924	408	19.9	20.5

Data based on observations at the U. S. Ginning Laboratory at Stoneville, Miss.

Original packing of bales at gins. - A systematic recording of the nature and location of the outs on bales observed during compression has confirmed the theory advanced by some compress operators that a large proportion of the outs that occur during compression are attributable primarily to the manner in which the bales are originally packed in the gin press box. 7/ Apparently, one of the basic causes of cutting is the lack of uniform distribution of the cotton in the bales as packed at the gin. Relatively dense masses of lint in certain parts of the bale cause uneven pressure during compression and this is accompanied by a shearing of the fibers at points of uneven density.

For the most part, uneven density within gin bales is caused by the building up of relatively dense masses of cotton known as "dog ridges" which are caused by the action of the dog mechanism of the gin press. Detailed observations have shown that most of the outs occur when the dog ridge is positioned at a tie channel in the compress. The more densely packed ridge frequently is forced into the channel starting a shearing action at the platen that moves downward into the bale parallel to the sides of the dog ridge.

More than 90 percent of the outs have been observed to occur in the top and near the outer edge of the bales (table 26). This location coincides with the location of the dog ridges (fig. 6). The dog ridges become more pronounced in the top portion of the bale, as tension on the dog mechanism increases progressively with each addition to the quantity of cotton in the press box during the packing of the bale. Likewise, the ridges built up by the dog mechanism extend inward into the bale only a few inches, depending upon the distance the dogs protrude into the press box.

The gin packing of cotton has been studied in detail at approximately 200 gins, the bales from which have been observed during compression. These observations indicate that the prominence of the dog ridges and the resultant cutting during compression are determined primarily by the weight and condition of the cotton packed in the bales. Increased tension on the dogs of the gin press, as a result of the packing of extra-heavy bales or of very dry cotton, accentuates very materially the building up of the dog ridges, accompanied by cutting when the bales are compressed.

7/ The authors wish to acknowledge the assistance of J. M. Johnson of the Houston Compress Company and C. H. Brillhart of the Traders Compress Company in making available the results of their investigations of bale cutting.

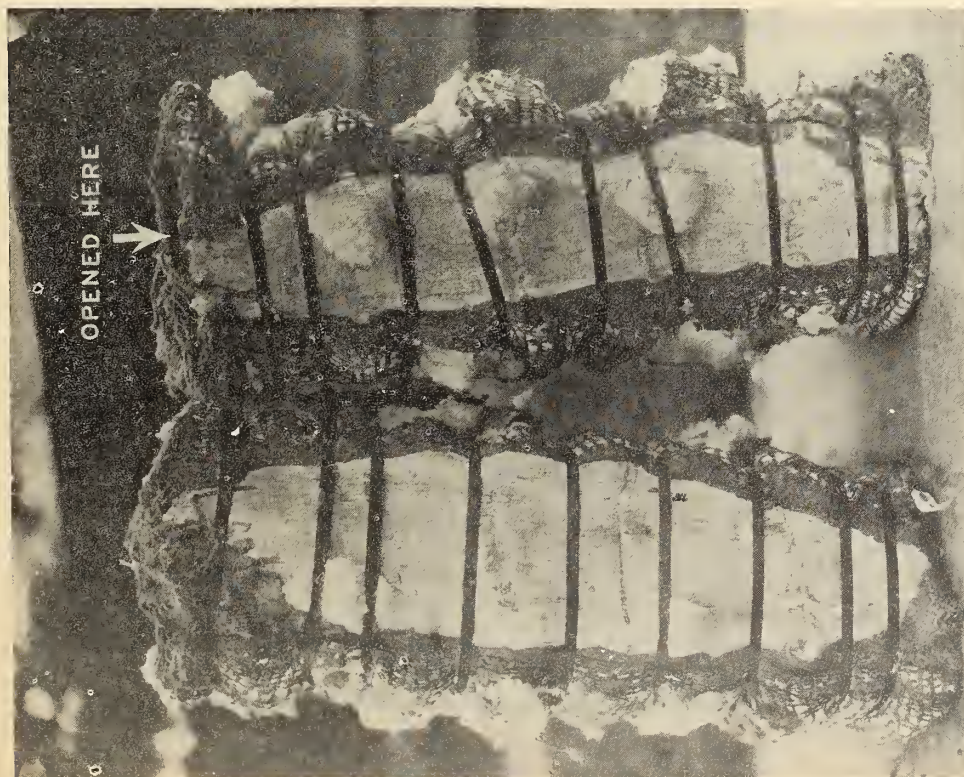


FIGURE 6. - CUTS IN HIGH-DENSITY BALES.

On the left, the "tumors" on the sides of the bales are the result of cutting during compression. On the right, one of the bales opened at the point indicated by the arrow shows the cuts following the contours of the "dog ridges" in the bale.

Table 26. - Percentage distribution of outs, by position in cotton bale, severity of cutting, and type of compression

Location and severity of outs	Type of compression	
	Standard density	High density
	<u>Percent of outs</u>	<u>Percent of outs</u>
Top of bale:		
Slight outs	19	24
Medium outs	64	41
Severe outs	10	27
Bottom of bale:		
Slight outs	2	4
Medium outs	5	3
Severe outs	1/	1
Total	100	100

Based on observations at commercial compresses, season 1938-39 and 1939-40.

1/ Less than 0.05 percent.

The shape and the method of operation of the press dogs appear also to influence the prominence of the dog ridges in gin bales. Bales packed in presses equipped with dogs that are inclined upward appear to be less susceptible to cutting than bales packed in presses having dogs of the straight design or dogs that are curved downward. In the case of some gin presses, there is considerable variation in the tension on individual dogs. For bales from a given gin, the most prominent ridges where cuts usually occur are found almost invariably associated with the dogs showing the greatest tension during the packing of the bales (table 27).

In order to provide a conclusive test of the effect of dog ridges in the bales on cutting during compression, 40 bales were packed experimentally at a gin where more than 90 percent of the bales packed were cut at the compress. Twenty of the bales were packed with the press-box dog mechanism operating, and 20 were packed with the dog mechanism removed. The seed cotton for the two groups of bales was divided so as to provide approximately identical conditions with respect to such factors as quality of cotton, moisture content, and

Table 27. - Relationship of variations in tension on gin press-box dogs to bale cutting during compression, by method of operation of dog mechanism and position of cuts in bale (high-density compression)

Number of cuts in bales packed at gins with tension on individual dogs --														Total		
Method of operation of dog mechanism and position of dog	Slight			Medium			Heavy			Very heavy			Number		Percent	
	Top of bale	Bottom of bale	Number	Top of bale	Bottom of bale	Number	Top of bale	Bottom of bale	Number	Top of bale	Bottom of bale	Number				
	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number				
Shaft operated:																
No. 1 front															44	10.2
No. 2 front						7									55	12.8
No. 3 front						18			2						71	16.6
No. 4 front						11			7						99	23.1
						1			11							
All front						37		6	20		118		41		269	62.7
No. 1 rear									8		12		6		31	7.2
No. 2 rear									1		19		2		28	6.5
No. 3 rear											42		1		46	10.7
No. 4 rear									1		50		4		55	12.9
All rear									10		123		13		160	37.3
Total shaft operated						37		6	30		261		54		429	100.0
Independently operated:																
No. 1 front	11	1	29		8		50		20		165		44		328	14.3
No. 2 front	3		24		8		25		12		221		101		394	17.1
No. 3 front	3		26		6		25		8		195		88		351	15.3
No. 4 front			14				10				82		14		120	5.2
All front	17	1	93		22		110		40		663		247		1,193	51.9
No. 1 rear			12		1		140		9		93		21		277	12.1
No. 2 rear			12		3		60		7		229		75		386	16.8
No. 3 rear			4		3		25		4		144		61		241	10.5
No. 4 rear	2				1		61		9		91		36		200	8.7
All rear	2	1	28		8		286		29		557		193		1,104	48.1
Total independently operated	19	2	121		30		396		69		1,220		440		2,297	100.0
Grand total	19	2	158		36		437		99		1,481		494		2,726	100.0
Percent	7	1	5.8		1.3		16.0		3.6		54.4		18.1		100.0	

Based on observations of 2,170 bales, season 1939-40

weight of bales. After packing at the gin, the bales were compressed to standard density. Detailed observations disclosed only 4 slight cuts on the 20 bales packed without the press-box dog mechanism as compared with a total of 207 cuts, or more than 10 cuts per bale, on the 20 bales packed with the dog mechanism in operation. This test corroborates the results reported by a commercial firm.

In order to ascertain more definitely the effect of localized increases in the pressure within a bale, experiments were conducted in which relatively dense materials were inserted in bales prior to compression to simulate the dense masses of cotton produced by the gin press-box dog mechanism. The materials used for this purpose consisted of 3-inch iron balls and pieces of 6" x 2-7/16" steel shafting. These materials were inserted in flat gin bales at various depths from the top of bales and near the edge between the dog ridges that had been formed during the packing of the bales at the gins. When the bales were compressed, cuts appeared directly above the inserted object in almost every instance (fig. 7). When these objects were moved from the edge to the center of the bales, cuts appeared at the center of the bales directly above the inserted object. These tests demonstrated that cuts could be produced at will by the insertion of dense objects and that the cuts produced in this manner between the dog lines were identical with those normally caused by dog-line accumulations of cotton.

There is evidence also that uneven density in gin bales, accompanied by cutting at the compress, is attributable to some extent to peculiarities of construction and operation of gin condensers, kicker-wheel mechanisms, and trampers. The uniformity of the condenser bat appears to have a direct influence on the extent of cutting during compression. The more uniform the bat, the more uniform is the bale density and the less susceptible is the bale to cutting during compression. Observations have been made of gin-packing equipment of all makes. Although there are wide differences in the extent to which bales from different gins are cut during compression, no gins have been found which turned out bales that did not cut at all.

Quality of the cotton. - A statistical analysis of data relative to the grade and staple length of the cotton in bales observed during compression has failed to disclose any definite relationship of cutting to these factors of quality.

The factor of maturity as an element of the character of the cotton does appear to be related to cutting. Although the relationship is not particularly pronounced, usually a higher percentage of bales containing a large proportion of thin-walled fibers are cut



FIGURE 7. - CUTS PRODUCED BY INSERTING DENSE OBJECTS IN BALES PRIOR TO COMPRESSION.

At the top, a severe cut caused by placing a 6" x 2-7/16" piece of steel shafting in a bale before it was compressed to standard density. At the bottom is shown a man's arm inserted through a cut caused by placing a 3" steel ball in a bale prior to compression to standard density.

during compression than of bales in which the proportion of such fibers is relatively low (table 28). This relationship apparently traces back to the relatively dense masses of cotton in certain parts of the bales. The building up of these masses appears to be accentuated in the case of the thin-walled fibers. The shearing strength of such fibers is relatively low and is exceeded at point where the stresses occur in the cotton during the process of compression.

Table 28. - Relation of thin-walled fibers in cotton to cutting of bales during compression

Thin-walled fibers (percent)	Bales out
	Percent
21 - 25	29.4
26 - 30	38.8
31 - 35	47.6
36 - 40	43.4
41 - 45	54.2
46 - 50	41.7
51 - 55	66.7
56 - 60	50.0

Data based on compress observations and laboratory determinations of fiber maturity of samples taken from bales compressed.

Type of bagging used. - Observations of the compression of large numbers of bales covered with open-mesh jute, sugar-bag-cloth, and cotton baggings have failed to indicate any definite relationship of cutting during compression to the type of bagging used.

Type and condition of compress equipment. - The available data show very significant differences between individual compresses in the extent to which bales are cut. The fact that this is the case even for bales of the same weight, the same type of cotton, and packed at the same gins, indicates that a part of the cutting is attributable either to the peculiarities of individual compress equipment or to its operation or both.

Observations with respect to bale cutting have been made for all types of compress equipment used in this country. Cutting occurred in connection with the compression of cotton by means of hydraulic and geared-mechanical presses as well as with the more generally used steam-cylinder presses.

In almost every instance where a cut was observed when a bale was compressed, it was found to be located adjacent to the side of a channel bar of the compress platen where the pressure exerted on the bale had forced the cotton into the tie channel. For this reason it was thought that possibly relative sharpness of the channel bars might affect bale cutting. A detailed study of this factor, however, disclosed the fact that more cutting occurs at compresses where the edges of the channel bars have become rounded from wear than at compresses where the edges of the channel bars are relatively sharp (table 29).

Table 29. - Relation of condition of channel bars and width of tie channels of compress platens to cutting of bales during compression, by type of compression

Condition of edge of channel bars	Average width		Percent of bales cut	
	: tie channel:	: of	Standard-density	High-density
			compression	compression
	: Inches	:	Percent	Percent
Square	1.26	:	21.2	16.5
Rounded	1.40	:	34.1	46.1

Data based on measurements and observations at typical commercial compresses.

Observations made at a compress equipped with channel plates that had been modified to reduce the number of tie channels and the width of the channels, disclosed a relatively low percentage of bales cut (figs. 8 and 9). Apparently the reduced number of tie channels provide less opportunity for cutting.

In view of the fact that about 90 percent of the cuts usually occur in the top of the bales where the dog ridges are most prominent, it is particularly significant that for a press equipped with the modified platens about 75 percent of the cuts observed during standard-density compression were in the bottom of the bales. In this instance, the lower standard-density platen was of the conventional type with the full number of tie channels, while the top platen was of the modified type.

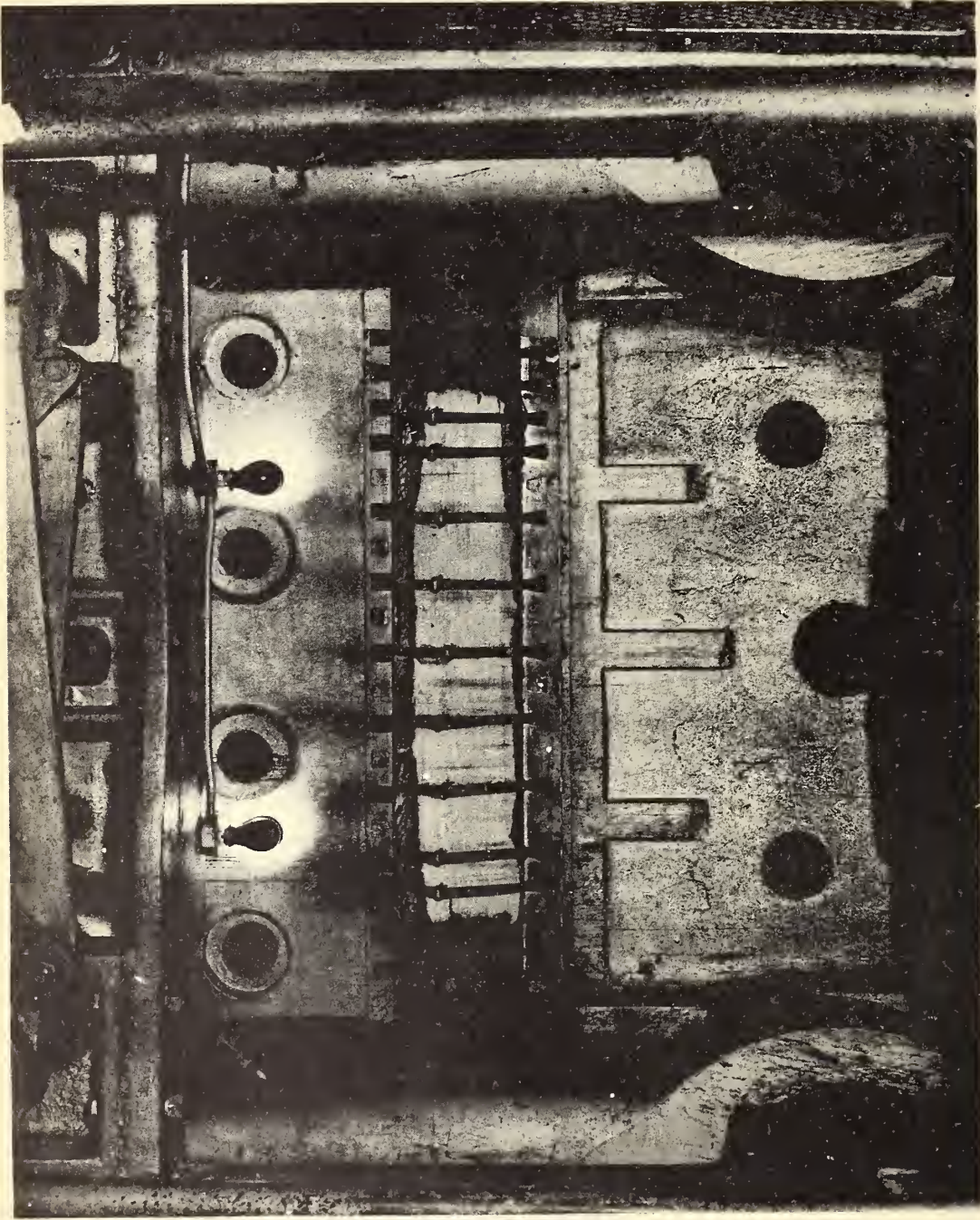


FIGURE 8. - MODIFIED TYPE OF COMPRESS PLATEN.

Upper and lower channel plates have been modified to reduce the number and width of the tie channels.

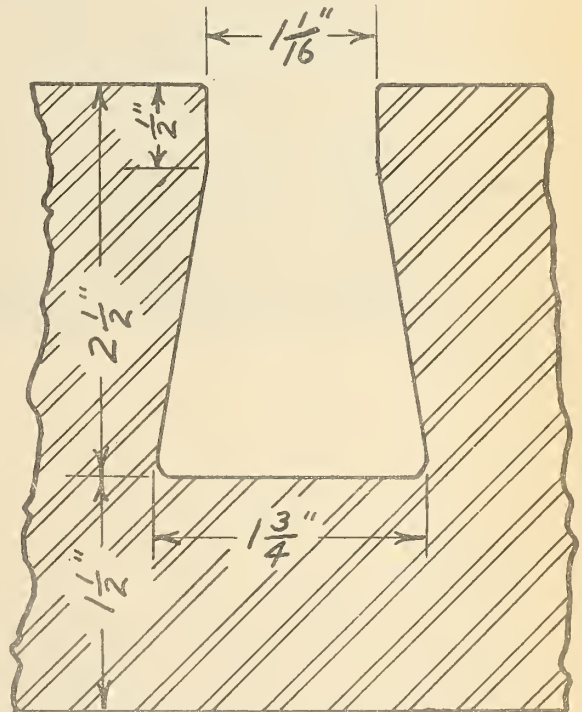
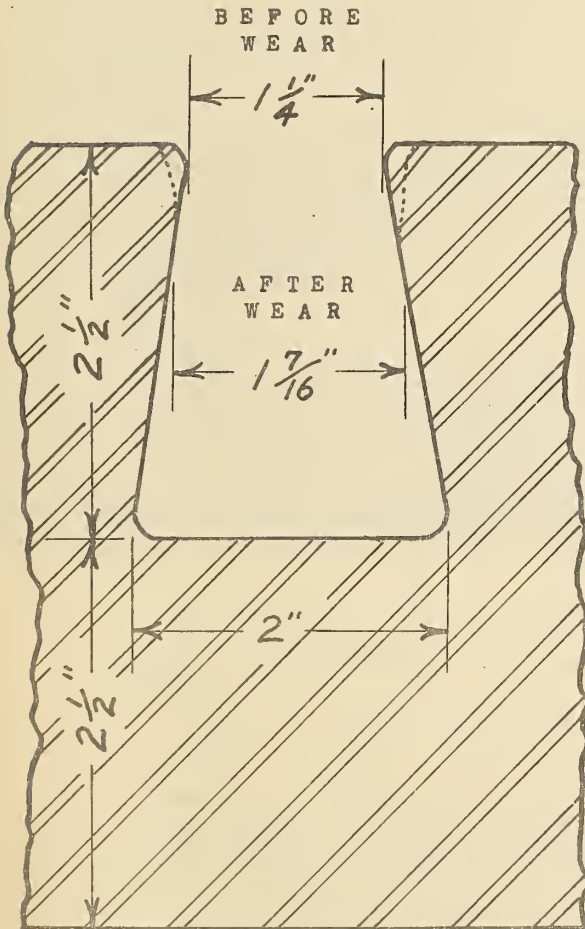
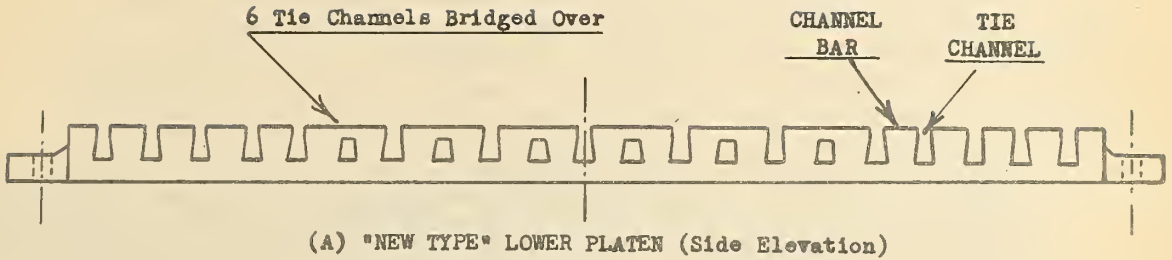


Figure 9 . - New type compress platen, with detail of tie channel as compared with old type:
 (A) Side elevation of new type lower platen showing reduced number of tie channels;
 (B) cross-sectional detail view of old type tie channel showing width of opening before and after wear;
 (C) cross-sectional detail view of new type tie channel showing how opening is constructed with flat side walls to prevent change in width with wear.

In order to test the theory that number and width of tie channels and the condition of the channel bars are factors in cutting, experiments were conducted in which boiler plate was used to blank off a portion of the compress platen so as to remove the effect of these features. This reduced very materially the amount of cutting. The few cuts which did occur were located at the dog ridges (fig. 10).

Conclusions. - Based on studies made to date, the following conclusions with respect to bale cutting during compression appear to be justified:

1. The cutting phenomenon is not a shearing of the cotton by air compressed within the bale.
2. Apparently cutting occurs as a result of the shearing action of uneven pressures in adjacent parts of the bale, which in turn are caused by the presence within the bale of relatively dense masses of cotton that are built up by the action of gin-packing equipment. The cutting occurs at the junction of the dense and the less dense parts of the bale.
3. Uneven density in gin bales is accentuated by the extra stress on gin-packing equipment which results from packing extra-heavy bales, and cotton of low moisture content, as well as by cotton containing a high proportion of immature fiber.
4. The degree of cutting at individual compresses is influenced by structural features of press platens and perhaps also by mechanical features of the operation of the presses.
5. Speed of operation of presses, kind of bagging used, and staple length of the cotton are not factors in bale cutting.
6. The cutting of bales during compression is not the sole responsibility of any single group in the cotton industry. This responsibility is divided between cotton growers, ginnermen, and compressmen. Practices of growers and ginnermen in connection with the condition of the cotton and the weight of the bales, of ginnermen in the manner in which the bales are packed from the standpoint of uniformity of density throughout the bale, and of compressmen in the type, condition, and manner of operation of their equipment, apparently will all have to be modified to some extent if this problem is to be solved.



FIGURE 10. - SEVERE CUT WHICH "PEELED OFF" ON SIDE OF BALE STARTING AT EDGE OF BOILER PLATE AND AT EDGE OF DOG RIDGE.

Note the prominence of the dog ridges on this bale.

Need for further studies. - Studies made to date have definitely established causes for the cutting of bales during compression. They have indicated that a substantial part of the cutting can be eliminated effectively by the relatively simple procedure of discontinuing the packing of extra-heavy bales at gins. In order to provide means for the complete elimination of cutting, there is need for concentrating further studies on developing practical means for the elimination of uneven packing of bales at gins and for the correction of the features of compress equipment responsible for the cutting of bales during compression.

Use of Sisal Twine

Many complaints have been registered by both foreign and domestic spinners concerning the use of twine made from sisal and other hard fibers for sewing the heads of cotton bales at the time of compression. It is claimed that the fibers from such twine become mixed with the cotton fibers and cause damage to spinning equipment and breakage in the yarn, thereby reducing output and increasing manufacturing costs.

The following excerpt from a letter addressed to the U. S. Department of Agriculture from an official of one of the leading foreign spinners' organizations presents the spinner's view of this problem:

"Various complaints have been received from spinners of affiliated countries regarding the use of sisal string in the baling of cotton. The string is used to tie the jute sacking, and becomes compressed into the open side of the bale. When the string is out at the mill a large number of fibres remain intermingled with the cotton, and it is these fibres which cause so many breaks in the spinning process; they are so strong they actually cut grooves in the metal rollers on the spinning machines, with the consequence that the rollers have to be replaced from time to time at a considerable expense.

"The Committee feels that the owners of ginneries and compresses should use cotton or jute string, preferably the former, for this purpose.

"The sisal fibres cannot be eliminated in the preparatory processes of spinning and if the shorter sisal fibres are taken forward into the yarn, they do not take the dye, making faulty places in the cloth, with the result that such cloth is classed as seconds or is eventually rejected by the buyer."

The following resolution was adopted at the meeting of the International Cotton Committee of the International Federation of Master Cotton Spinners' and Manufacturers' Associations held in Amsterdam on the 4th of May, 1937:

"It is essential that no sisal be used in the baling of cotton either as a covering or as a string. In the opinion of the International Committee of Cotton Spinners and Manufacturers, cotton string should be used in place of sisal string."

A survey of the cotton compress industry made during the cotton season 1938-39 showed that about 84 percent of the twine used for sewing the heads of compressed bales consisted of sisal, istle, and manila hemp -- all hard fibers. About 15 percent of the twine used was made from jute, and about 1 percent was made from cotton (table 30). Observations made on a limited scale during the season 1939-40 indicated a substantial decrease in the use of twine made from sisal and other hard fibers.

Table 30. - Proportionate use of specified types of twine for sewing heads of cotton bales at compresses, by States, season 1938-39

State	Type of twine used				
	Cotton	Manila hemp	Istle	Jute	Sisal
	Percent	Percent	Percent	Percent	Percent
Alabama		3.5	71.3	5.5	19.7
Arizona					100.0
Arkansas			4.9	9.4	85.7
California		16.7		35.4	47.9
Florida			100.0		
Georgia	2.1		23.7	61.9	12.3
Louisiana	.7		33.0	44.9	21.4
Mississippi		.2	88.8	9.0	2.0
Missouri					100.0
New Mexico					100.0
North Carolina				8.5	91.5
Oklahoma	.2	16.8		15.5	67.5
South Carolina					100.0
Tennessee					100.0
Texas	2.7	1.4	56.2	8.1	31.6
Virginia			50.0	50.0	
All States	1.1	2.3	41.5	14.9	40.2

Based on a survey of cotton compresses.

Inadequate Covering of Bales

The appearance of American cotton bales has been the subject of a great deal of adverse comment, particularly in foreign markets where American cotton must now compete with the neater bale packages of other cotton-producing countries. The principal contributing causes of the unsatisfactory appearance of American bales are: (1) the use, in covering bales at gins, of second-hand and other bagging materials that fail to withstand the wear and tear of shipment; (2) the practice of repeated cutting of the bales for samples; (3) the failure to use suitable patches for covering sample holes; and (4) the failure to exercise proper care in the placement of the bagging and ties when the bales are compressed.

It has been amply demonstrated that by the exercise of reasonable care in the placement of bagging while the bales are in the compress, the entire bale usually can be covered so as to give a neat appearance and to provide protection to the cotton during handling and shipment (fig. 11). Under customary methods the cotton on the sides of the bales is left exposed. The exposed surfaces are subject to stain from rust and paint from the ties and from other materials with which the bales come in contact in handling and shipment. Spinners report that this type of contamination of the cotton is very difficult to remove because of being at right angles to the layering of the cotton and requiring hand picking.

The proper placement of the bagging and ties while the bales are in the compress, and the proper patching of bales containing sample holes are the joint responsibility of compressmen and cotton merchants. Although exercise of greater care on the part of compressmen in turning out neat and properly covered bales would require a little more time and effort, there is definite need for a greater interest on the part of many compressmen in turning out a job representing creditable workmanship.

Cotton merchants, in some instances, appear to be indifferent concerning the appearance of the bales merchandised by them. They are concerned primarily with securing sufficient density upon compression to enable them to take advantage of the most favorable transportation rates, with adding sufficient weight in patching material to take full advantage of the tare allowance under which the cotton is sold, and with securing the services of compression and incidental items at the lowest possible cost. Obviously the problem of providing a satisfactory bale package by the compress industry should have the active attention and encouragement of cotton merchants, as the delivery of goods in neat packages is an elementary principle of good merchandising.

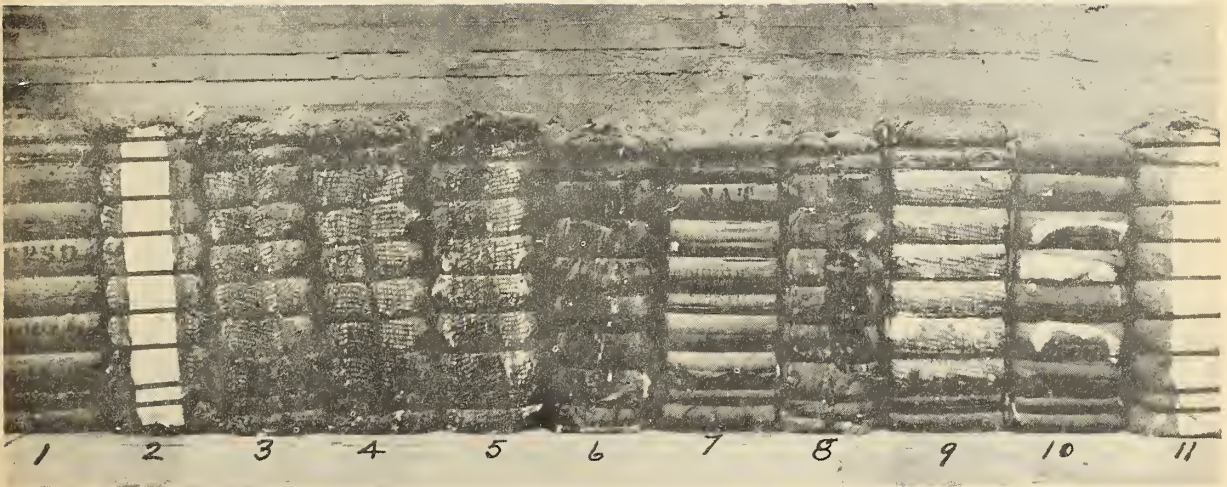


FIGURE 11. - COMPRESSED BALES SHOWING THE NEAT APPEARANCE AND ADEQUATE PROTECTION TO COTTON OBTAINED BY THE EXERCISE OF CARE IN THE PLACEMENT OF BAGGING, TIES, AND PATCHES WHEN THE BALES WERE COMPRESSED.

Factors Limiting Compressing Capacity

The size and condition of cotton bales as received at compresses affect very materially the facility with which the process of compression can be performed. Bales of irregular shape and extra weight cause loss of time in handling through the press, and they limit output accordingly.

Bales of irregular shape are usually classified by compressmen as "rolling bales", "big-ended bales", and "heavy-sided" bales. "Rolling bales" are a source of considerable trouble in compressing (fig. 12). In order to turn out a satisfactory job, such bales have to be rebuilt before they are compressed. This operation consumes considerable time and delays compressing accordingly. Apparently, the various irregular types of bales are caused by the improper operation of gin-packing equipment.

The disadvantage of extra-heavy bales from the standpoint of cutting during compression has been discussed previously. There are other disadvantages in these bales from the standpoint of the compress industry. Frequently the condition in which such bales are received at compresses causes much extra trouble in handling (fig. 13). Many of them are too big to go between the compress platens and a part of the cotton has to be removed and replaced after the remainder of the bale has been pressed. This requires an extra operation of the compress equipment and reduces accordingly the volume of cotton that can be handled within a given time. In many instances, very expensive compress machinery has been damaged by excessive stress in compressing extra-heavy bales. Although the elimination of extra-heavy bales is the direct responsibility of cotton growers and ginnermen, compressmen can aid in various ways in discouraging the packing of such bales.

Foreign Material in Cotton Bales

Cotton manufacturers have reported on numerous occasions the presence, within bales of American cotton opened at their mills, of such objects as bale buckles and other particles of iron and steel, as well as many other foreign materials. The presence within the cotton of pieces of iron or steel is particularly objectionable because when such materials get into mill machinery with the cotton they frequently cause fires and serious damage to the machinery.

Perhaps much of the foreign material complained of gets into the bales through carelessness when they are packed at the gin. It appears likely, however, that the presence of bale buckles in the cotton, which are a source of much of the manufacturing difficulty, is primarily attributable to careless methods of removing and handling ties and buckles when they are removed from gin bales prior to compression.



FIGURE 12. - END VIEW OF A "ROLLING BALE" AFTER COMPRESSION TO STANDARD DENSITY.



FIGURE 13. - EXTRA-HEAVY BALE WITH 3 TIES MISSING UPON ARRIVAL AT COMPRESS.

Ink Stains

Shippers' marks customarily are stenciled on cotton bales before the cotton is shipped from compresses. Indelible ink usually is used for such marking. In most instances the marks are placed on the sample faces of the bale over the bagging or patches. Since the marking ink used penetrates very readily through the bale covering into the cotton, considerable lint becomes stained. The ink being indelible cannot be removed in the bleaching processes, so it must, in most instances, be removed by hand picking when the bales are opened at the mill. This involves extra time and, in the aggregate, a considerable loss of cotton. Such stains present an even more serious problem when the marks are placed directly on the cotton on the sides of the bales, as is sometimes done.

The need for these methods of marking bales at compresses would be obviated by the adoption of the permanent bale identification tag that has been developed by the Department (fig. 14). ^{8/} Shippers' marks could be attached to these tags to facilitate the identification of the individual bales with a particular lot being shipped. Since, however, the successful use of these tags would depend upon their universal adoption for American cotton, there is need in the meantime for the development of a more satisfactory marking material for use at compresses.

SUMMARY

The cotton compress industry occupies an important position in the present system of marketing and handling American cotton. The existing system of packaging cotton at gins in bales of low density requires, in most instances, that the bales be compressed to greater density in order to effect economies in transportation and storage. The cotton trade also depends on the compress industry for various services incident to the concentration and merchandising of cotton.

The initial development of compress facilities took place at cotton ports and was prompted by the necessity for economy in ship cargo space. The first heavy machinery for compressing was installed at New Orleans in 1832. The first high-density steam compress equipment similar to that now commonly in use, was developed about 1900. The first press of this type was installed at Savannah, Ga.

Cotton compresses are now distributed throughout the entire Cotton Belt. They usually are located at strategic points with respect to areas of cotton production and lines of movement of the cotton.

^{8/} Wright, J. W., and Gaus, G. E., Permanent Identification of Cotton Bales, U. S. Department of Agriculture, July 1937 (Mimeographed).

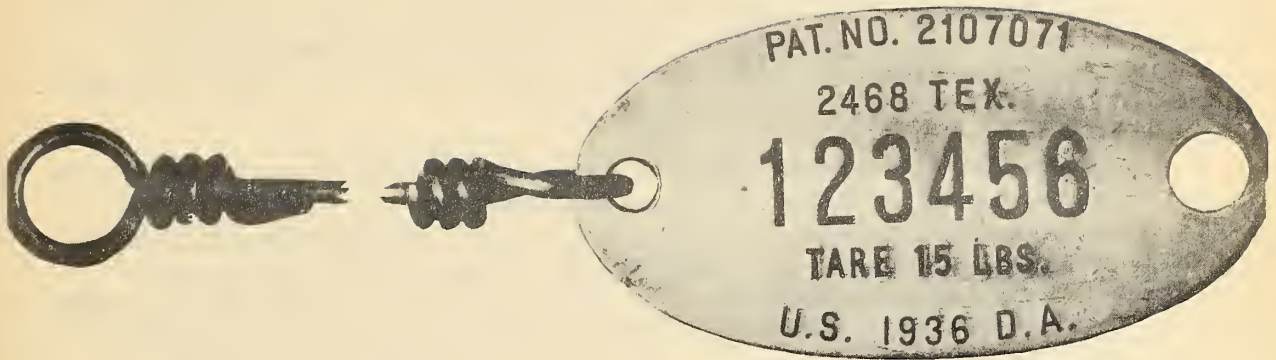


FIGURE 14. - PERMANENT IDENTIFICATION TAGS FOR COTTON BALES.

Top section shows actual size of tag. The over-all length of the anchoring wire is 28 inches so that it penetrates about one-half the length of the gin bale. Lower section shows tag in head of standard compressed bale.

In 1939 there were 324 compress establishments in the United States, including 358 press installations. Twenty-eight compress establishments were equipped with 2 presses each, and 3 were equipped with 3 presses each. A total of 336 of these presses were in active operation during the season 1938-39. Of the total press installations in the United States, 287 were equipped for both standard-density and high-density compression, and 71 were equipped for standard-density compression only.

There are three types of compress equipment now in use in the United States. These are steam cylinder, hydraulic, and geared mechanical. Present installations consist of 333 steam-cylinder presses, 9 hydraulic presses, and 16 geared-mechanical presses. During the season 1938-39, about 95 percent of the cotton compressed was compressed by steam-cylinder presses, 1 percent was compressed by hydraulic presses, and 4 percent was compressed by geared-mechanical presses.

Some of the steam presses weigh as much as 350 tons. The total pressure exerted on the bales of cotton during compression varies from about 625 to 1,375 tons.

On the average, about 95 bales per hour are compressed to standard density and 85 bales per hour are compressed to high density. The volume of cotton compressed per hour is considerably greater for steam-cylinder presses than for other types.

The dimensions and the density of cotton bales vary materially. On the average, gin bales are about 56 inches in length, 28 inches in width, and 44 inches in thickness. The average density is about 13 pounds per cubic foot. Standard-density bales average about 56 inches in length, 30 inches in width, and 22 inches in thickness. The average density is about 24 pounds per cubic foot. High-density bales average about 57 inches in length, 22 inches in width, and 22 inches in thickness. The average density is about 33 pounds per cubic foot. Both dimensions and density vary directly with the weight of the bales.

As cotton compress equipment and related facilities represent a relatively large investment, the industry is, for the most part, operated as large-scale integrated enterprises. Approximately 75 percent of the compresses, handling about 78 percent of the cotton, are operated by chain organizations. The management of the major portion of the compress facilities of the United States is closely affiliated with the merchandising of cotton.

The annual volume of cotton handled per press varies from less than 5,000 bales to about 200,000 bales. The United States average for the season 1937-38 was about 35,000 bales per press.

For the Cotton Belt as a whole, about one-third of the cotton compressed is pressed to standard density and two-thirds to high density. This varies by regions. In the Mississippi Valley, most of the cotton is compressed to standard density for shipment to domestic mills, whereas in the Southwest most of the cotton is compressed to high density for export. About 15 percent of the cotton compressed to standard density is recompressed to high density.

The distribution of cotton from compresses located at interior points varies materially for each of the three major cotton-producing regions. In the Southeast, about 90 percent of the cotton is shipped direct from compresses to domestic mills, and the remainder is shipped to ports. About 90 percent of the cotton from compresses located in the Southwest is shipped to ports, and about 10 percent is shipped to domestic mill points. In the Mississippi Valley States, about 58 percent of the cotton is shipped from compresses to domestic mill points, about 29 percent is shipped to ports, and 13 percent goes to interior concentration points.

The customary charge for the compression of cotton over most of the Cotton Belt is 60 cents per bale for standard density and 75 cents per bale for high density. Charges for receiving cotton and for the performance of services incident to the concentration and merchandising average approximately 25 cents per bale. For the season 1939-40, storage charges averaged 20 cents per bale per month.

A number of special problems merit the attention of the compress industry. Among these are the cutting of bales during the process of compression, the appearance of the bales as turned out at compresses, foreign materials in the cotton, suitable methods of marking bales, suitable twine for sewing the heads of bales, and limitation of compressing capacity by extra-heavy and irregular-shaped bales.

Investigations of the cutting of bales during compression indicate that the theories of cutting by air compressed within the bales, excessive speed of compression, and kind of bale coverings used are untenable. The actual cause of cutting appears to be uneven packing of bales at gins which is accentuated in the case of extra-heavy bales, extra-dry cotton, and cotton with a high proportion of thin-walled fibers. There is considerable variation in the proportions of bales cut for different gins. Likewise, there are variations in the extent of cutting at different compresses. Apparently the elimination of cutting during compression will involve modification of gin-packing equipment and compress equipment and the discontinuance of the packing of extra-heavy bales. Although the effect

of bale cutting on the spinning value of the cotton is not very important, damage to the bale package, the extra time required to handle cut bales at the compress and more particularly the adverse reaction of spinners justify an effort to eliminate such cutting.

The appearance of bales turned out at compresses and the protection afforded the cotton can be improved at a slight but warranted additional cost by the exercise of greater care in the placement of bagging, patches, and ties when the bales are compressed.

Care in the removal of buckles and ties when the bales are opened for compression is needed to prevent these materials from getting into the cotton and causing damage to mill machinery.

The use of cotton or jute twine for sewing the heads of bales would eliminate the problem encountered by spinners because of the contamination of the cotton with hard fibers from sisal and other twines made from hard fibers.

Improvements in the packing of bales at gins so as to eliminate bales of irregular shape and excessive weight would facilitate the compression of the bales.

Among other outstanding advantages, the universal adoption of a system of permanent identification of individual bales of cotton would obviate the need for marking bales with indelible ink, which results in the staining of considerable cotton.

